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PLATE I. — View of a golf course showing the fine quality of turf desired on a putting-green.

TURF FOR GOLF COURSES

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PREFACE

THE remarkable development of golf in the United States within the past decade has led to an insistent demand for more knowledge in the art of growing grass turf. For golf purposes there is required a much finer type of turf than for lawns and greenswards, so that the knowledge gained in reference to lawn-making has been inadequate to meet the situation. As a result of this ignorance, there has been a great waste of effort and money by golf clubs, amounting in the aggregate to an enormous sum.

At first sight the growing of a piece of fine turf seems to be a simple matter, and this has misled many persons to underestimate woefully the difficulties to be overcome. Even to grow a good lawn is usually a matter of much care and considerable skill. One can obtain a fair index of the ease or difficulty in growing good turf by the lawns in each locality. Where these are generally poor, turf-growing is sure to be no easy problem. Too often reliance is put largely in fertilizers or in seed mixtures,

without the realization that either of these, however meritorious it may be, is but one of many factors requisite for success. It must be admitted frankly that our knowledge of fine turf-culture is yet far from adequate, but if what is known is utilized intelligently, much needless waste of effort and money may be avoided. Indeed, in many cases there is positive knowledge that certain methods are not desirable in attempting to grow turf, while it may be less clear which one of other methods is most trustworthy.

In this treatise on the subject applying especially to American golf courses, the aim of the writers has been to present existing knowledge in as simple and straightforward manner as possible. On many problems there is yet need of much critical experimentation, and until this is accomplished, there will continue to be doubt as to the best methods.

The authors desire to express their heartiest thanks to the officials of the United States Golf Association for their encouragement in preparing this treatise, and their assistance in securing its prompt publication.

C. V. PIPER,
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TURF FOR GOLF COURSES

CHAPTER I

GENERAL VIEW

GOOD grass turf is conditioned by two great factors — climate and soil. The latter can be modified but the former must be accepted as it is. As all of our cultivated turf plants are of Old World origin, the matter of climate has a very direct bearing on the behavior of the same grasses in America. Every American who sees the wonderful Bluegrass and Creeping Bent lawns of England marvels how it is done. As a rule he is content to accept the hoary story that has done such veteran service: "First you level it and seed it and water it; then you roll it and roll it and roll it — for about a hundred years, and there you are." It's a good story and, like many another good story, has the merit of not being true. At least, as an explanation of the superior turfs of old England, it is not the truth. The examples are few where success has been se-

cured in the eastern United States in making permanent turfs comparable to those of England, though there has been time enough if long-continued rolling were the only requisite. As a matter of fact, most American lawns become hopelessly deteriorated within five or six years in spite of better care than English lawns receive, including abundant rolling. There is one region in the United States, however, in which lawns nearly as good as those of England are the rule, namely, Oregon and Washington west of the Cascade Mountains. This region has a climate more nearly approaching that of England than any other part of America, the drier summers constituting the principal difference. One can follow an English treatise on lawns in that region and secure admirable results. Elsewhere in the United States one is apt to score a failure.

The basic difficulty in growing really fine turfs in the northern half of the United States lies in the fact that all of the good temperate lawn grasses are native to western Europe and adapted to European climatic conditions. Taken to the United States these grasses have to contend with the greater extremes of heat in summer and of cold in winter. Not only does the heat weaken their growth greatly

in midsummer, but it also stimulates the growth of summer weed competitors like Crab-grass and Goose-grass, which are practically unknown factors in Europe. In short, the best northern turf grasses require cool temperatures and ample moisture throughout the growing season. Where either of these factors is absent, the grasses fail to do their best. Where they are both present, success is practically certain. On the famous golf course at Nuwara Eliya, in the mountains of Ceylon, it never freezes, but the whole year is cool and moist. The putting-greens are covered with a beautiful turf of Creeping Bent — as fine, indeed, as one may see anywhere.

Inasmuch as our climate cannot be changed to suit the grasses, the only practicable thing to do is to make the soil conditions as nearly ideal as possible. It is a well-established principle of plant culture that the more unfavorable the climatic conditions are, the more favorable must all other conditions be to insure success, and grasses are no exception to this rule. It cannot be too strongly emphasized that the growing of a fine piece of turf requires as great care and attention to details as does the culture of any other ornamental plant.

Too often a lawn or green is sown without any knowledge of the grasses planted or of their special requirements, and it is only by sad experience that one learns how difficult it is to grow a fine piece of turf.

A really good golf course must have fine putting-greens. It is unfortunate that it is rare to find a piece of land sufficiently rough for ideal golf where the soil conditions are also present for perfect putting-greens. Every golfer is familiar with the fact that the sporty golf courses of the country do not possess nearly as good putting-greens as those which have been laid out on approximately level farm lands. Nevertheless, first-class putting-greens can be secured anywhere in the North, provided sufficient attention be given to securing proper soil. This is sometimes a matter involving large expense at the outset, but in the end it is far more satisfactory than to worry along year after year with the handicap of poor turf.

It often happens that a golf club has insufficient capital at the outset, and it is impracticable to delay opening the course. This usually involves playing on poor putting-greens, and the club struggles on year after year hoping that the greens will improve.

It is a very difficult matter to build up poor greens into good greens, and this can never be done short of several years' time. Every golfer knows from experience how long a poor green will be tolerated when its betterment involves the using of a still poorer temporary green.

THE CLIMATIC RELATIONS OF TURF GRASSES

Broadly speaking, the United States may be divided into two climatic regions, north and south, so far as a perennial grass turf is concerned. Generally speaking, southern grasses are adapted to about the same region as that in which cotton-culture is important, but some thrive only where the winters are warmer, namely, in Florida and along the Gulf Coast. As a matter of detail, every turf grass has definite limitations of its own as indicated in the discussion of each, but the broad climatic requirements of northern grasses are much alike, as are also those of southern grasses.

The accompanying map (Fig. 1) shows approximately the climatic region in which Bermuda-grass will survive the winter and also the region in which Creeping Bent will thrive throughout the year. Temperature is the main factor determining the

limits in which these two grasses can be satisfactorily cultivated. Of course in the drier areas of the West a supply of water must be provided to insure success with either.

Treated as a summer annual, Bermuda-grass can be grown to the northern boundary of the

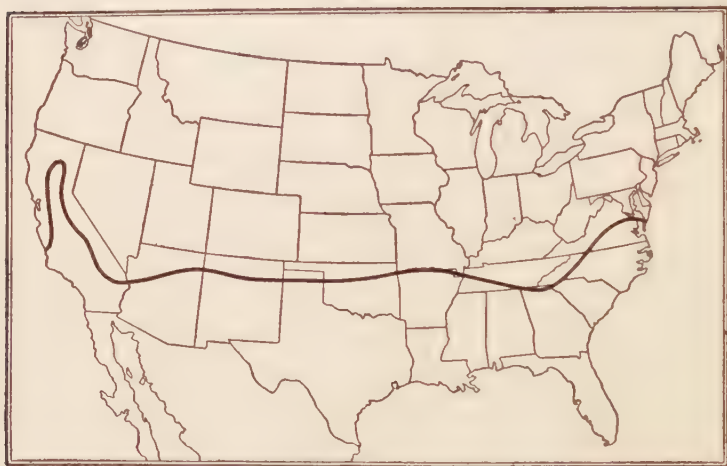


FIG. 1.—Outline map of the United States, showing the approximate northern limit of the area where Bermuda-grass will survive the winter. This line is also near the southern limit of the area in which Creeping Bent will thrive throughout the year.

United States, but north of the limit indicated on the map it rarely survives the winter. In a similar manner Creeping Bent can be grown in the South if planted in the fall, and it will make a satisfactory turf during the cool season, but succumbs to heat and weedy grasses during the early summer following.

Other northern turf grasses such as Rhode Island Bent, Kentucky Blue-grass, Redtop, Red Fescue, and the like have approximately the same climatic limitations as does Creeping Bent.

Of southern turf-formers, Japan Clover and Korean Lawn-grass are adapted to about the same region as Bermuda-grass, while Carpet-grass is not vigorous north of Charleston and Montgomery. Generally speaking, most northern turf grasses cannot be satisfactorily grown, except in the mountains, south of the parallel marked by the southern boundaries of Virginia, Kentucky, Missouri, Kansas, Colorado, and Utah. It will be noted that the southern limit of these grasses approximates the above-mentioned parallel, and the same is true of the northern limit of Bermuda and other southern grasses.

This relation of every grass, and indeed of every plant, to climatic conditions is inherent in each species, and in botanical language is spoken of as an adaptation. It is of course easy to understand why Bermuda-grass rarely survives north of Maryland, because it is killed by winter cold. Fundamentally, however, the reason why Creeping Bent succeeds so easily in New England and survives

only with great care in Virginia is because it is not adapted to withstand the summer conditions in the latter state.

Natural adaptations can apparently be modified within narrow limits by careful and long-continued breeding. Really, what is done is to select those plants that succeed best under given conditions and to breed from these. While such work has progressed far with our common annual crops, it is much more difficult with perennials, but marked progress has been made with such plants as fruit-trees. Thus far the cost of the work and the lack of prospective rewards have not encouraged any such breeding work with turf grasses.

The difficulty of growing any grass satisfactorily increases as the limits of its climatic adaptations are approached. In other words, northern grasses give less satisfaction near their southern limit of culture, while southern grasses are rarely worth cultivating near the northern limit of where they will endure the winter.

This matter of climatic adaptations is fundamental with turf grasses as well as with other plants. It alone often determines what particular grass is best to grow in a particular region. Bermuda-

grass in the North would be folly, and scarcely less so are attempts to make permanent greens in the South of Creeping Bent or of Red Fescue. But it requires experimenting and critical judgment to determine under given conditions whether to use Red Fescue or Creeping Bent on a putting-green or Kentucky Blue-grass or Redtop on a fairway.

CHAPTER II

SOILS FOR TURF GRASSES

THE special soil requirements of the various turf grasses differ considerably, but for the best results they all require a deep, fertile, moisture-holding yet well-drained soil. Such an ideal soil must be a loam, clay loams being better for most turf grasses than are sandy loams. Silt loams are in general intermediate in value. A good garden soil is a close approximation of what is most desirable. If such soil is underlaid by a permeable clayey subsoil to permit deep growth of roots and to provide underground drainage, the best possible soil conditions are present.

Such soil conditions are rarely found on golf courses excepting where they have been constructed on good farming land. In such cases the problem of securing good turf is rarely a matter of difficulty, better drainage being commonly the main thing needed.

Most golf courses are, however, located on land of low agricultural value not only on account of the much smaller initial cost of such land but also to secure the rough or rolling topography so desirable for sporty courses. The soils of such areas near the seacoast or lake shores are very often sandy in texture; elsewhere they are commonly stiff clays, as gravelly soils are avoided for golf purposes whenever possible. It is on such sandy or heavy clay courses that the problem of securing good turf becomes difficult. Unless the plans for the improvement of such a course so that it will grow good turf are based on sound principles, a large amount of time and money can easily be spent and only unsatisfactory results be secured.

The problems on the two types of soil are best considered separately, as the methods of soil improvement to be employed are quite different. Furthermore the particular grass or grass mixture to be used in each case is a matter of prime importance. These statements refer more particularly to the fairways, as on the putting-greens much larger sums of money must be spent with the idea of securing the most nearly perfect greens.

SOILS FOR PUTTING-GREENS

For putting-greens every effort should be made to secure as nearly perfect soil conditions as possible before seeding the green. It is a serious error to seed putting-greens before a satisfactory soil has been established, as this can never be entirely remedied later by any system of top-dressing. Furthermore, it is a notorious fact shown in the history of many clubs that poor putting-greens will be tolerated a long time if their reconstruction involves the use for a period of still poorer temporary greens. As a putting-green is intended to be permanent, its soil foundation should be as nearly ideal as possible.

The texture of an ideal turf soil is a loam, which may vary from a sandy loam to a clayey loam. Where the soil has to be made artificially, it is most likely to be a sandy loam in sandy regions and a clayey loam in clayey regions.

Sandy soils are bettered by the addition of silt or clay, or both, so as to obtain in the surface foot about one-third of these materials. Where clay is used, it should be dry and pulverized, as otherwise a good mixture is not secured. Humus-

forming materials should be added in large quantity, preferably enough to cover the green to a depth of three or four inches. The thorough mixing of these different elements will form a satisfactory sandy loam soil. In some seaside courses the error has been made of attempting to build a green by making a layer of peat eight to twelve inches thick and covering with a few inches of soil, but good results are not to be expected from any such method. Peat remains practically inert unless well mixed with soil. Preferably, it should be composted for a full year before using.

Stiff clay soils are best improved by the admixture of sand and humous materials. Three to four inches of sand may advantageously be incorporated in the top twelve inches, together with a liberal amount of humus-forming materials. Enough of the latter to cover the ground to a depth of four inches is not excessive. When the clay, sand, and humous materials are thoroughly mixed by plowing and cultivating, a very fair substitute for a clay loam is secured.

In some cases it may be cheaper to carry good soil to cover the proposed green to a depth of at least six inches, but good soil for turf is usually

scarce when the prevailing soil is either very clayey or very sandy.

In the North, the clayey loams are best seeded to Creeping Bent and the sandy loams to Red Fescue. Mixtures of these two grasses have in some cases at least given very excellent results, but usually one is better than the other, dependent largely on the difference in soil mentioned.

The depth of the good soil should be at least six inches, but more preferably eight to twelve inches or more. The shallower depths will answer with a good subsoil; the greater depth is highly desirable and sometimes necessary with a poor subsoil.

The subsoil should be permeable to roots and well-drained. If its consistency be too compact for good natural drainage, tiling is demanded. If the subsoil be gravel or coarse sand that will not retain moisture, the surface soil must be deep and preferably a rather clayey loam. No method of irrigation to offset the handicap of very rapid drainage will prove satisfactory.

The fertility of the top soil should be high. The soil should contain a high percentage of vegetable matter, as good turf of any kind requires an abundance of humus. The most desirable fertilizers

are organic in nature, namely, cottonseed-meal, bone-meal, tankage, and the like. Animal manures are always most excellent but should be well rotted and practically free from weed seeds. Lime should rarely be used on putting-greens.

The moisture-holding capacity of the soil should be high. This is best insured by a good content of clay and of vegetable matter.

The drainage should be ample so that the soil never becomes water-logged. Water-logging may be caused either by lack of surface drainage or by absence of subsoil drainage or by deficiency in both. When a green is flanked by a hillside, especial drainage is necessary to take care of the seepage coming out of the hill. In wet seasons this is often very injurious. Surface drainage must always be provided. If any saucer-shaped depression occur in a green, the turf in the hollow, especially if it be Creeping Bent, will turn yellow. In general it may be said that wherever Creeping Bent turns yellow the drainage is defective.

It must be admitted that satisfactory putting-greens have been established where one or more of the above-mentioned factors are lacking. Such cases do not demonstrate that the omitted factor

is of no consequence, but merely that the other conditions are unusually favorable. No hard and fast rules can be laid down that will insure the securing of good turf under any conditions, as the factors involved are numerous and far from being thoroughly understood. So far as our knowledge goes, however, all of the factors emphasized are of prime importance, and it is rare that any one of them can be neglected and good results be achieved. The rare cases where good results are secured by haphazard methods are simply exceptional.

IMPROVING SANDY SOILS ON FAIRWAYS

The growing of satisfactory turf on the fairways of golf courses where the soil is sandy in texture is often difficult, depending mainly on the degree of sandiness of the soil, but partly on the available grasses adapted to the region. Sandy soils may be classified as follows: coarse sands, fine sands, sandy loams, fine sandy loams.

Neither coarse sand nor fine sand will produce a satisfactory growth of turf. In both cases a surface soil must first be secured, which is always an expensive process. This may be done by either of two general methods. (1) By covering with a layer

of good soil. This should be at least three inches deep and preferably of a clayey loam, as much sand will become mixed with it in the process of hauling and leveling. (2) By mixing vegetable matter and clay in the sand to a depth of about six inches. Where the vegetable matter is readily available in the shape of muck or peat, it is cheapest to use this material. Where such humus is not cheaply available and time is not important, a crop of rye, cowpeas, or other plant adapted to sandy soils may be grown and plowed under. Vegetable matter and sand alone are, however, not sufficient, binding material of clay or silt being essential to make a real soil. Clay is not easily mixed with sand unless it be dry and pulverized.

Sandy loams contain about twelve per cent of clay and usually about twice this amount of silt. Such soils will grow good fairway turf if the proper plants be used. In the North the best plants for the purpose are Red Fescue, Rhode Island Bent, and White Clover. The latter is especially important as it does not require nitrogenous fertilizers. Whatever objections may be held against White Clover on putting-greens, they do not apply on fairways. Redtop is also useful. Sheep's

Fescue and Hard Fescue are both well adapted to sandy lands, but should never be used on fairways, as they are strictly bunch grasses. What turf they make gives objectionably cuppy lies for the ball. Red Fescue will thrive equally well and make a true creeping turf. The other fescues are desirable only in the rough, where they are excellent on account of their tough tussocks and deep roots, which enable them to prevent washing and blowing of the soil. Blue-grass is rarely useful on sandy soils.

In the South the available turf plants for sandy soils are Bermuda-grass and Japan Clover for summer, and Italian Rye-grass, Redtop and White Clover for winter. Where Carpet-grass thrives it is an excellent all-the-year grass.

Established turf on sandy fairways can best be maintained by periodic surface dressings of a good clayey loam rich in humus. On courses where peat and clay are available, this soil should be made by composting the peat and the clay in alternate layers of each about four inches deep, with an occasional layer of barnyard manure. This latter furnishes an abundance of bacteria so necessary to bring about the further decomposition of the

peat. A small amount of lime, preferably ground limestone, may be scattered on each layer of peat, and this will intensify the bacterial action. Such compost heaps should be prepared at least a year in advance of their use, and a longer period is preferable.

IMPROVING CLAY SOILS ON FAIRWAYS

The improvement of stiff clayey soils so as to produce satisfactory fair greens is usually less difficult and costly than is the case with poor sandy soils. The important difficulties usually encountered are that the surface soil puddles and bakes easily, and the subsoil is often impervious. The latter is serious only on flat land, and can be corrected by tiling. Stiff clay soils can be made to produce good fairway turf by the use of humus-forming material, either barnyard manure or the plowing under of a green crop. Lime is rarely necessary or advisable unless Blue-grass turf be desired. It is usually desirable to plow such land before seeding so as to incorporate the humus-forming materials added. Furthermore, by proper seeding a much better turf will nearly always be secured than can be hoped for by attempts to im-

prove such grass cover as already exists. Judgment must of course be exercised in this matter, as there is no need of plowing under turf that is fairly good, for this can be bettered simply by top-dressings of manure and by seeding. Steep hillsides should in particular be left undisturbed, as serious damage by washing may occur. It is safer to improve the turf on such slopes by top-dressing methods.

In case sand or sandy soil can be secured cheaply and in abundance, it is an excellent plan to use it to top-dress very clayey fairways. Not only does the sand make a better surface soil for golf purposes, but it helps the grass both by absorbing the rainfall much better and by preventing baking in dry hot weather. The cases are rare, however, where sand occurs in abundance on or near a clay land course.

In the North most turf grasses succeed well on clayey soils. For general purposes a mixture of Redtop, Blue-grass, and White Clover is cheap and satisfactory. If preferred, the White Clover may be omitted, but it is practically certain to appear, whether sown or not.

In the South Bermuda-grass and Japan Clover for summer turf and Italian Rye-grass, Redtop, Blue-grass, and White Clover for winter turf are

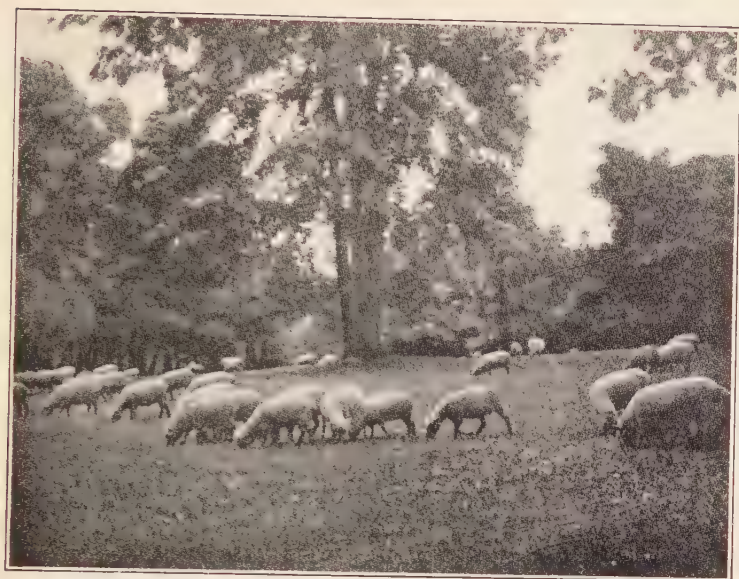


PLATE II. — Upper. Sheep are often used on golf courses in Europe to keep the grass short. The same method could well be used in most northern and western States.

Lower. A sample of good muck which makes an excellent top-dressing for turf.

most satisfactory. Such clayey soils in the South are all located in the hilly regions away from the seacoast, and on such soils, at least where the altitude is 1000 feet or more, Redtop, White Clover, and Blue-grass usually live through the summer and begin new growth with the cool weather of fall. Where such winter grasses do not come naturally each season in sufficient abundance to form good turf, they should be supplemented by fall sowing of Italian Rye-grass. This grows rapidly and will make an excellent turf during the winter, but disappears about the time the Bermuda-grass turf becomes good in early summer.

On the better golf courses in the North, the present tendency is to sow only the fine bents and Red Fescue on the fairways, thus producing a turf nearly equal in quality to that on the putting-greens, but which is not clipped so closely. The growing of such turf on the fairways requires a larger expenditure for seed than where Blue-grass and Redtop are used, but provided the soil conditions are satisfactory the cost of the seed is the principal additional expense.

ACID OR SOUR SOILS

An acid soil in the agricultural literature of the day is commonly defined as one on which most farm crops are stimulated by the application of lime. Such soils will usually turn blue litmus paper red when the moist soil is left in contact with the paper for a few minutes. On the basis of this test a large percentage of the area in the eastern half of the United States is acid. When it is desirable to correct soil acidity, it is usually done by applying lime in some form. There are several methods to determine the relative acidity of a soil and by this means ascertain its "lime requirement," that is, the amount of lime necessary to neutralize the soil of one acre to a depth of eight inches. The "lime requirement" of a very acid soil is frequently as high as five tons an acre.

In speaking of "lime requirement," many writers make the tacit assumption that a neutral or slightly alkaline soil is best for cultivated crops, and that acidity is in general harmful. Another way of looking at the problem is that the lime acts directly on the plant as part of its food, and not indirectly as a correction of soil acidity. This is the older view and in accordance with it plants have been

classified as calciphiles or lime-lovers, and calciphobes or lime-haters. Thus Alfalfa, Red Clover, Blue-grass, Bermuda-grass, and many other plants favor a limestone soil, and their growth is helped by this substance. On the other hand, rhododendrons, huckleberries, and other plants will not thrive when there is an appreciable amount of lime in the soil.

So far as the turf grasses are concerned, their relations to lime may be very simply stated. Blue-grass is much benefited by lime while White Clover and Bermuda-grass are considerably improved. Other turf grasses, including Creeping Bent, Rhode Island Bent, Redtop, Red Fescue, Sheep's Fescue, Japan Clover, are almost indifferent to lime, being neither appreciably bettered nor injured on most soils except as the liming stimulates the growth of Blue-grass, White Clover, and various weeds.

At the Rhode Island Experiment Station plots of various turf grasses alone and in mixtures were planted in 1905. On one series the plots were fertilized with chemicals leaving an acid residue, on the other with chemicals leaving an alkaline residue. After ten years the most noticeable result was that the plots treated with alkaline fertilizers were all very weedy, while those treated with acid ferti-

lizers were not weedy. The acid plots of Rhode Island Bent, Red Fescue, and other fescues were still in excellent condition. The grasses on the other acid plots were almost entirely replaced by Rhode Island Bent.

On portions of the plots not clipped, the growth of the grasses in all cases was greater on the alkaline plots than on the acid plots. This larger yield is important agriculturally, but not from a lawn turf standpoint. The closely clipped turf both on the alkaline and acid plots was dense and fine, but on the former was much inferior, due to the prevalence of weeds.

The lesson from this series of plots is backed up by numerous observations elsewhere. It teaches clearly that Rhode Island Bent and Red Fescue are acid soil plants and on such soils will maintain themselves with little difficulty. If, however, lime or other alkaline fertilizers are used, weeds and other grasses will likely invade the turf.

DRAINAGE

Good turf is rarely seen except on well-drained soil. It is true that some turf grasses like Redtop succeed well in moist or wet soil, but under such

conditions several undesirable plants like rushes and sedges always appear. Furthermore, ill-drained land is very objectionable on a golf course because during some seasons at least the ground becomes soggy, and the turf is injured and made uneven by trampling.

On putting-greens especially the drainage should be ample, but on fairways it is also necessary. A common indication of poor drainage is the occurrence of certain characteristic plants such as thyme-leaved speedwell, selaginella, and various sedges in the North and dichondra and *kyllingia* in the South.

Satisfactory drainage is best secured by the use of drain tiling. On putting-greens which require drainage, four-inch tiles should be placed in lines about six feet apart and at the proper depth to collect the seepage and carry it away. On good permeable loams the tile should be eighteen to twenty-four inches deep; but if the soil is not very permeable they should be placed at a depth which will permit them to collect the seepage. Where a putting-green is flanked by a bank or hill, a line of tiles at the base of the bank or hill to collect the seepage is necessary.

Inadequate drainage on a putting-green composed of Creeping Bent is always promptly indicated by the grass turning yellowish. If a green be so constructed that there are shallow concavities without surface outlet for drainage, the grass in such places is sure to turn yellow. Drainage in these cases may be secured by the use of a "soak-away," that is, a vertical column of sand or other permeable soil to connect with a tile or other subterranean drainage. As a rule, however, a putting-green should be so constructed that there are no hollows unless these have broad surface outlets.

Tiling is also frequently very important on fairways, but as these are rarely watered artificially the tiles need not be so close together.

Subterranean drainage to putting-greens is sometimes secured by the use of a layer of rubble or clinkers in the foundation, one to two feet below the surface of the green. To some extent such a drainage layer reduces the trouble from earthworms, but the disadvantages scarcely compensate for this slight benefit. A drainage layer is expensive to construct in the first place, and sooner or later will become entirely clogged by silt carried in the seepage waters.

While good drainage, either surface or subterranean, is necessary to secure turf, it must be remembered that its only function is to carry off surplus water so that the soil will not become soggy and the plant-roots thus deprived of air. Good drainage alone will not insure good turf, as nearly any piece of sandy or gravelly soil will demonstrate. There must also be fertile soil.

CHAPTER III

FERTILIZERS

THE term "fertilizers" is an extremely broad one, having been applied generally to all substances that are added to the soil for the purpose of improving its capacity to produce plant growth. Almost every common substance has at some time or other been used for this purpose, but since 1840, largely as the results of Liebig's investigations, the number of substances used as fertilizers has been restricted to those containing relatively high percentages of nitrogen, phosphorus, and potassium, except in the case of organic manures, which have always been used extensively.

The functions of fertilizers are not clearly known, but they are probably very much more complex than is commonly supposed. In addition to supplying nitrogen, phosphoric acid, and potash to the soil in forms available to plants, some of them, at least, act as correctives or disinfectants ameliorating toxic conditions, while others, of which

barnyard manure is an example, in addition to these functions supply organisms that are highly beneficial to plant growth. Hundreds of carefully planned pot, plot, and field experiments have been conducted within recent years, but as yet no highly scientific practice has developed with regard to the use of fertilizers, so that "cut and try" methods are still very largely necessary.

Commercial fertilizers may be divided into two general groups, organic and inorganic. To the former belong bone-meal, cottonseed-meal, dried blood, and hoof-and-horn-meal. To the latter belong nitrate of soda, sulfate of ammonia, acid phosphate, raw rock phosphate, basic slag, and muriate and sulfate of potash. In addition to these there are many others of less importance in each group. The fertilizers most commonly used for grass are ground bone in some form, nitrate of soda, sulfate of ammonia, cottonseed-meal, acid phosphate, and muriate and sulfate of potash.

ORGANIC FERTILIZERS

Organic fertilizers consist of dead plant or animal materials. As a class they are relatively slow in action and correspondingly long enduring. In gen-

eral, their function is to supply nitrogen, although some of them contain a high percentage of available phosphoric acid.

Bone-meal.

In the comparatively long list of organic commercial fertilizers bone-meal is the most popular at the present time for use on grass. This is very largely due to the fact that it is relatively cheap and can be depended on to produce reasonably consistent results. For putting-greens it has three distinct advantages: it is a fertilizer to which grass responds very readily; it can be applied at any season of the year with little or no injury to the finest turf grasses; and there is no evidence of its producing unfavorable residual effects in the soil. The common objection to its use on putting-greens is based on the belief that it unduly encourages the growth of White Clover by virtue of its relatively high percentage of phosphoric acid. While it doubtless benefits clover, nevertheless the extreme prejudice on the part of golfers apparently is not well founded.

There are two kinds of bone-meal found on the market: "raw bone" and "steamed bone." In the case of the former no treatment is given the

bone before grinding, while in the latter case the bone is subjected to superheated steam until the fat and the scraps of meat have been removed. Steamed bone is said to be somewhat more readily available than raw bone; but whether raw or steamed, the value of bone-meal depends to a very large extent on the degree to which it is pulverized. The finer the particles, the more quickly the substance becomes available to the plants.

A good grade of bone-meal contains from 3 to 5 per cent of nitrogen, and from 18 to 20 per cent of phosphoric acid. For top-dressing putting-greens twenty pounds to 1000 square feet are recommended. When used at the time of seeding, somewhat heavier applications can be made to advantage. It is the common practice to apply bone-meal in the spring, but there is some evidence to indicate that when applied during the winter it is more beneficial to the grass when growth commences. Late spring or summer applications, while no doubt somewhat efficacious, produce results that are only slightly noticeable, at least in the appearance of the grass. No scalding or other injurious effects have ever been observed from the use of this fertilizer, no matter when applied. Its

offensive odor can be considered only a slight objection to its use, since it is not long in evidence after application.

Cottonseed-meal.

Highly satisfactory results have been obtained in many cases from the use of cottonseed-meal as a top-dressing for grass turf, but whether it is to be recommended for putting-greens in preference to bone-meal is open to question. Thus far there is lack of sufficient definite data to warrant a positive statement in this connection. Cottonseed-meal contains more nitrogen than does bone-meal, and its nitrogen is more quickly available. Furthermore, its low percentage of phosphoric acid eliminates any theoretical objections to its use on the ground of encouraging White Clover. A suitable application when used as a top-dressing for greens is approximately twenty-five pounds to 1000 square feet. It frequently happens that a scorching or burning effect results when cottonseed-meal is applied to grass. The reason for this is not well known, but the scorching may be due partially to the heat which is generated by fermentation when the meal becomes moist or wet. Therefore, it should be distributed as evenly as possible and

worked into the turf with a coarse brush or broom, or it may be mixed with equal parts of sand or soil before applying. This obviates the danger of large quantities accumulating and injuring the grass. Masses of cottonseed-meal, if thoroughly wetted, become hard and almost impervious to moisture upon drying. Under such masses the grass is almost invariably killed. For the above reasons, caution should be exercised in connection with its use, especially in summer, since its scorching effect is apt to be greater at that time than at any other period of the year.

Cottonseed-meal is manufactured from the decorticated seed from which the oil has been expressed. It ordinarily contains approximately 7 per cent of nitrogen, 1.5 per cent of phosphoric acid, and 2 per cent of potash. It is desirable that it be given a thorough trial as a spring top-dressing for putting-greens.

Dried blood.

As a top-dressing for turf, dried blood has not given very consistent results. This may be due partly to the fact that the availability of its nitrogen is somewhat uncertain, depending very largely on the character of the soil to which the fertilizer

is applied. In soils deficient in lime it is frequently not more than one-half as available as nitrate of soda, while on soils well supplied with lime the availability is increased to a point more nearly approximating that of nitrate of soda. A good grade of dried blood contains from 10 to 13 per cent of nitrogen, 0.5 to 1.5 per cent of phosphoric acid, and 0.6 to 0.8 per cent of potash. It can be used with safety on the finest turf, and this seems to be its most commendable feature, since its use is not economical, and it is neither lasting nor consistent in its action. A normal application consists of approximately twenty pounds to 1000 square feet of putting-green.

Hoof-and-horn-meals.

Meals composed of ground hoofs or horns, or a mixture of these two, have sometimes been suggested for putting-greens in preference to bone-meal, owing to the comparatively low percentage of phosphoric acid which the substances contain. Experience, however, indicates that only a small portion of the nitrogen in these meals is available, even though the material is finely pulverized. Furthermore, the nitrogen becomes available very slowly, and while a good grade of these meals contains approximately

13 per cent of nitrogen, their use on turf has not given very satisfactory results.

INORGANIC FERTILIZERS

There occur in natural deposits in the earth substances that contain to a high degree of concentration the principal elements of plant-food. Nitrates and potash compounds are found in impure chemical salts, while phosphates exist in a much less concentrated form in rocks, many of which are composed very largely of fossil animal remains. *Nitrate of soda.*

The most important inorganic nitrogenous fertilizer is nitrate of soda. It occurs in a crude state in large deposits in South America, and is refined there before being exported. In its commercial form it contains between 15 and 16 per cent of nitrogen, which is equivalent to 18 to 19 per cent of ammonia. Nitrate of soda is readily soluble, and its nitrate becomes immediately available without undergoing any chemical decomposition. It produces the quickest effect of all the commercial fertilizers when applied to grass, and is fairly consistent in its results. Its effects, however, are not very lasting, and because of this it is

not very generally recommended as a fertilizer for the fairway.

On account of its pronounced caustic effect, nitrate of soda must be used with extreme care on putting-greens. It is preferable to apply a small quantity at frequent intervals rather than large quantities at one time. Five pounds for every 1000 square feet of green is a sufficient quantity for one application. It should be pulverized thoroughly, and it is preferable to mix with sand before applying and to water thoroughly afterwards. Nitrate of soda may also be put in solution at the rate of one pound to ten gallons of water and sprinkled on the green, but even when used in this way thorough watering afterwards is necessary. Still another method which renders its use less likely to cause injury is to mix a saturated solution of it with bran, sawdust, or a similar substance before applying to the grass. This method reduces the burning to a minimum. It can be used to advantage during the spring and autumn, but its use in the summer is not recommended. Agricultural chemists have classified nitrate of soda as physiologically basic, and there is considerable evidence that it has a tendency to correct soil acidity as the

result of the formation of sodium carbonate. However, residual effects of considerable quantities of sodium carbonate on heavy clay soils deficient in humus are far from beneficial, and in addition to these deleterious effects the constant application of nitrate of soda, paradoxical as it may seem, has a tendency to impoverish the soil of its supply of nitrogen. These objections should be given careful consideration, since in the case of putting-greens applications of fertilizers are very much heavier than are made in ordinary farm practice.

Sulfate of ammonia.

Sulfate of ammonia is another inorganic salt that carries a high percentage of nitrogen, and is in a measure a competitor of nitrate of soda. It is a by-product resulting from the distillation of coal, as in the manufacture of coke and gas. It appears on the market in the form of a fairly fine whitish salt, and contains approximately 20 per cent of nitrogen, or 24 per cent of ammonia. Unlike nitrate of soda, sulfate of ammonia is acid in its residual reaction, and its continued use may result in producing such an acid condition in the soil that fertility is greatly reduced. For this reason, if for no other, nitrate of soda is to be preferred.

It frequently has been stated that one or two applications of sulfate of ammonia will eradicate white clover from putting-greens. However, the evidence on this is far from convincing. The tendency of continued applications of this fertilizer to create an acid condition in the soil is certain to be unfavorable to the growth of clover, but it is also unfavorable to the best growth of grass. The deleterious effects of sulfate of ammonia are neutralized by sodium, potassium, and calcium carbonates, but unless it is with the view to eradicating clover, this fertilizer possesses no known advantage over nitrate of soda. If it is desired to try it for the above purpose, ten pounds to 1000 square feet of green is considered a normal application. While not as readily available or as burning in its action as nitrate of soda, the same precautions are necessary with regard to its use.

Acid phosphate.

The phosphorus-carrying inorganic fertilizer in most common use is acid phosphate. It is prepared chiefly by treating phosphatic rocks such as are found in large deposits in several of our southern states with sulfuric acid to render the phosphorus content more available to the use of plants.

The good commercial grades contain from 14 to 16 per cent of phosphoric acid.

The effect of acid phosphate on grass is generally quite beneficial, especially when applied with some form of nitrogen, but it also stimulates the clovers, and for this reason few favor its use on putting-greens. For the fairway it may be used advantageously in many cases as a constituent of a complete fertilizer in the absence of suitable manure or compost. In such cases applications should be made preferably in the early spring at the rate of approximately 1000 pounds to the acre. For the greens it appears to possess no advantage whatever over finely ground bone-meal. In fact, this is true of all mineral phosphates. However, if for any reason it is desired to use it on greens, the application should be attended with considerable care, inasmuch as the free acid which it commonly contains readily injures grass which is in an active growing condition.

Muriate and sulfate of potash.

Muriate and sulfate of potash are by far the most important potash-bearing fertilizers now in use. They occur in impure deposits in Germany, and, when refined, yield salts containing 80 to 85

per cent potassium chloride, and approximately 90 per cent potassium sulfate, respectively. Most of the clay soils of this country are believed to contain an adequate supply of potash to produce a good growth of grass, and while experiments have shown that comparatively small quantities of potash salts in combination with nitrates and phosphates may increase the growth of turf grasses, these fertilizers are seldom recommended for putting-greens, except in cases where the soil is very sandy. Like the phosphates, potash fertilizers appear to increase the abundance of clover in the turf. In fact, their tendency apparently is more pronounced in this respect than is that of either acid phosphate or bone-meal. Five pounds for 1000 square feet of green is an ample application when combined with other fertilizers.

Mixed fertilizers.

It is a common practice of commercial fertilizer companies to mix fertilizing materials in different proportions with the view to selling them for special conditions. These ready-mixed fertilizers are extensively advertised under various trade names such as "Turf Grower," "Grass Grower," "Lawn Fertilizer," and the like, and the opinion seems to

prevail in the minds of many that they are just what is required. While these mixed fertilizers are very generally used, they are not to be recommended. Commercial concerns possess no special information regarding the action of fertilizers on grass that an intelligent greenkeeper cannot soon acquire, and, therefore, there is nothing mysteriously beneficial in their formulas.

When mixed fertilizers are desired, it will be found cheaper and generally more satisfactory to buy the ingredients separately and combine them in suitable proportions. By so doing the purchaser does not have to pay a high price for a considerable quantity of inert filler that is commonly present in ready-mixed fertilizers. The proportions for a good complete fertilizer for turf are as follows: nitrate of soda or sulfate of ammonia, 250 to 300 pounds; phosphoric acid, 350 to 500 pounds; muriate or sulfate of potash, 100 to 150 pounds. Twenty pounds of this mixture for 1000 square feet is ample for a single application, and three such applications are sufficient for a season. Inasmuch as this mixture is a concentrated fertilizer, precaution is necessary in connection with its use in order to avoid scalding the grass.

CHAPTER IV

MANURES, COMPOSTS, AND OTHER HUMOUS MATERIALS

A **VERY** important factor in maintaining the fertility of a soil is the upkeep of its humus content. Organic matter in the soil has many functions that cannot be performed by other fertilizing substances. It improves the texture of the soil and betters aëration, water-holding capacity, and drainage. In addition, it furnishes material by means of which beneficial soil organisms may promote nitrification and produce other important biological changes.

By the proper use of suitable organic matter, a high degree of fertility can be maintained indefinitely. This cannot be said of mineral fertilizers, no matter how liberally or wisely they may be used. First-class permanent turf can be had only on soils that are well supplied with humus, or decayed vegetable matter. There are many forms of organic matter that can be used advantageously

on putting-greens if properly prepared. Barnyard manure, good compost of various kinds, and peats or mucks are all suitable, and one or more of these substances is available to every club in the country.

Barnyard manure.

Barnyard manure is the most commonly used humous dressing; not that it is ideal, but because it possesses qualities that are not found in other humous materials. The chief objections to its use as a top-dressing for putting-greens are that it ordinarily is too coarse, and that it is a carrier of weed seeds. These objections can be obviated, but unless they are overcome they are decidedly serious. While manure offers the most value as a fertilizer in a fresh condition, it should be thoroughly rotted when used as a dressing for greens. If well-rotted, most of the weed seeds are killed and the material is much more easily comminuted. The practice of applying coarse manure to fine turf in the fall and winter, and raking off the coarse material in the spring, cannot be recommended, but a liberal dressing of well-rotted and pulverized manure in the fall, winter, or early spring can result only in benefiting the grass.

The question is commonly asked, When may

manure be said to be well-rotted, and how long must it remain in a pile or pit before the weed seeds in it are killed? As concerns its texture, manure is well-rotted when it breaks up readily upon being worked over with a fork or mixer, and when so handled is reduced to a quite uniform consistency. The quantity of straw or litter in the manure, and the conditions under which it is composted, have much to do with the period required for decomposition.

As for the length of time required to destroy weed seeds, the evidence is not very definite. Some critical investigations that have been conducted recently indicate that one year is sufficient to kill all common weed seeds, and only half a year to devitalize a large percentage of them. Experience, however, indicates that it is neither safe nor desirable to use manure that has been composted for less than one year, and composting for two years is preferable. With proper planning, a supply of thoroughly rotted manure can be had at all times.

Powdered sheep manure.

When sheep are fed for some time in small inclosures, large quantities of manure — which is composed almost exclusively of the solid excre-

ment from the animals — accumulate. This material is sometimes dried, pulverized, and placed on the market in bags, and is subject to the same regulations as other commercial fertilizers. Powdered sheep manure has some advantages over ordinary barnyard manure, since it appears in a good mechanical condition and is free from weed seeds. However, it seems to lack the strength or substance necessary to make it always effective, and it is too expensive for the results which it produces to be used economically on putting-greens.

Mushroom soil.

Mushrooms for market are usually grown in cellars or caves, upon soils that are composed very largely of manure from horse stables. After the soil has been in use for one year it is no longer suitable for mushroom-culture, and is consequently replaced by a fresh supply. This partially exhausted material makes a very satisfactory humous dressing for turf. It is sufficiently decomposed to break up into the proper degree of fineness, and contains few, if any, viable weed seeds. While it varies considerably in quality, it can be purchased cheaply, and is highly recommended for use on putting-greens when properly comminuted.

Compost and composting.

The term compost has at times been applied to all mixtures used as fertilizers. At the present time, however, it is restricted by common usage to mixtures of sod, manure, leaf-mold, peat, lime, and various other substances that have been placed in piles or pits to promote decomposition. Compost is used extensively by gardeners and florists, and is their most common form of humus. As prepared by them, sod is its principal constituent, leaves, leaf-mold, and manure making up varying proportions as their needs may require, or as these materials are available. As a dressing for turf, a good compost can be prepared by piling sod in alternate layers with manure, leaves, and leaf-mold. To this mixture, or any similar mixture, lime in some form, preferably pulverized limestone, should be added. Regardless of the kind of grass to which the compost is to be applied, lime is very necessary in the preparation of compost. It has an important function in reducing the raw vegetable matter to a suitable form of humus by neutralizing the organic acids that develop and by promoting bacterial activity. In making compost, 100 pounds of pulverized lime should be used to each ton of

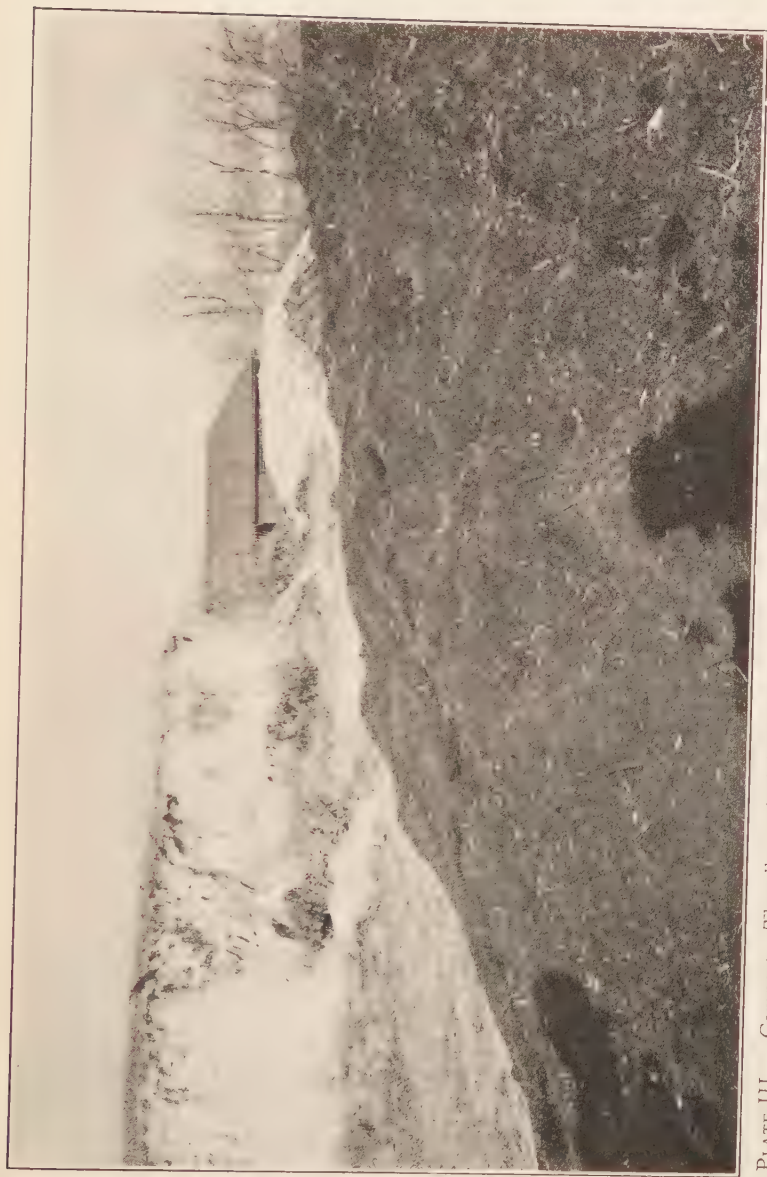


PLATE III. — Compost. The pile on the left is sod and manure in alternate layers 1 year old; the dark pile on the right is New Jersey muck. By the use of the machine shown in Plate IV, these two may be intimately mixed.

vegetable matter. If a considerable quantity of green vegetable matter is present, hydrated lime is preferable to pulverized limestone. There should be at least some manure in every compost pile, if for no other reason than because of the bacteria and other beneficial organisms which it introduces.

How long compost should remain in the pile before being used depends, to a very large degree, on the nature of the materials entering into it. Sod, leaf-mold, and manure will reach a very satisfactory degree of decomposition in one year if properly mixed. Six months' time is frequently sufficient to bring about the decomposition of green vegetable matter. There are no accurate data on the length of time required, and, therefore, the only safe course is to provide favorable conditions for decomposition and to allow as much time as possible. Even well-rotted compost should be screened to remove the coarse material and thoroughly mixed and comminuted before being used. Compost prepared in this way is so valuable, and at the same time relatively so cheap, that every club should see to it that an adequate supply is available at all times for use on its course. With a little attention, a good quality of manure

can be obtained, and it is entirely practicable to produce sod on unused portions of the club's grounds for composting purposes. (Plates III and IV.)

Leaf-mold.

In its untreated state leaf-mold, which is usually composed of leaves, twigs, roots, and similar vegetable matter in various stages of decomposition, is not a suitable form of humus for putting-greens. In fact, such material should be used only in the making of composts, or at least should be treated with lime before being used. Although leaves contain considerable quantities of lime, their partial decomposition produces an acid condition in the soil, and it is not until they are almost completely decomposed that they produce an alkaline reaction. When composted with lime, and also preferably with manure and sod, leaves and leaf-mold can be converted into a very useful form of humus.

Peat.

Peat is the remains of plants that have been decomposed, or at least partially so, in water. The consistency of peat varies from scums or slime to solid substances, in which the texture of the plants has almost, if not quite, disappeared. When peat

occurs naturally in a granular condition, it is usually called muck (Plate II), and all so-called muck soils are of peat origin. Peat is found in large deposits in many parts of the country, and its various forms have been the subject of investigations from an agricultural standpoint for centuries. Peat in the form of muck is a very valuable form of humus if properly utilized. It has a high water-holding capacity, and when incorporated with the soil it improves the texture and performs other important functions. Furthermore, it is of the proper consistency for application as a top-dressing, and is free from weed seeds. In its natural condition, however, it is seldom that muck is suitable either as a top-dressing for turf, or for mixing with the soil, since in some cases it contains a high percentage of salts that are injurious to grass, while in other cases it is highly acid in its reaction.

Recently in this country, muck, both in a treated and untreated form, has been placed on the market as humus under various trade names. Some of these commercial products are very crude, and it is doubtful whether their use can be recommended, especially from the standpoint of economy. Investigations show quite clearly that muck should

be thoroughly aërated by frequent stirring for a long period prior to use, and thoroughly leached by exposure to the weather under conditions of good drainage. This treatment greatly improves its value. It frequently has been recommended that muck be composted with lime and manure in order to hasten fermentation, since it is almost devoid of organisms that promote decay.

As a result of the work of an English investigator, there has been placed on the market recently a form of peat or muck inoculated with active cultures of nitrogen-fixing bacteria. It is claimed that this greatly increases its value by adding active nitrogen-fixing organisms to the soil under suitable conditions for nitrogen fixation, and in stimulating the nitrogen fixers already in the soil. Peat, treated according to this method, has not been tested extensively in this country, but it is reasonable to believe that almost equally good results can be obtained by composting it with a good quality of manure. Some American firms farm their peat beds for a year or two, then dry the muck, and mix it with other fertilizing ingredients, so that when placed on the market it is a standardized product. This treatment doubtless improves its

quality, but adds greatly to the cost. While properly prepared peat has many advantages for use on putting-greens, it frequently is so expensive that it cannot be applied economically. It is, therefore, always well to consider it in comparison with barnyard manure, which is a standard humous material. On the basis of a large number of analyses, it is estimated that in fertilizing constituents one cord or three tons of manure is equal to three and a half cords of muck, while on the basis of organic matter one cord of manure is equal to one and one-half cords of muck. A comparison of manure with air or kiln-dried muck would appear more favorably for the latter. From the above figures, it appears perfectly evident that a golf club is not justified in paying a high price for raw, wet muck when a better grade of humus can be had from properly composted manure, or mushroom soil. If a deposit of peat or muck is available to the club, it can be used very profitably. No matter in what form, or from what source obtained, muck should be mixed with sand or loam before being applied as a top-dressing to turf, and afterwards wetted thoroughly; otherwise, it will blow away upon becoming dry.

Street sweepings.

The conflicting results that have been obtained from the use of street sweepings as a fertilizer are probably due to the nature of the streets from which they were obtained. In times past street sweepings were recommended highly on account of their quick action, but of recent years sweepings from asphalt and other modern pavements have been considered even harmful to vegetation. Actual experiments have shown them to have a toxic effect on turf, and it therefore seems advisable to warn against their use on putting-greens.

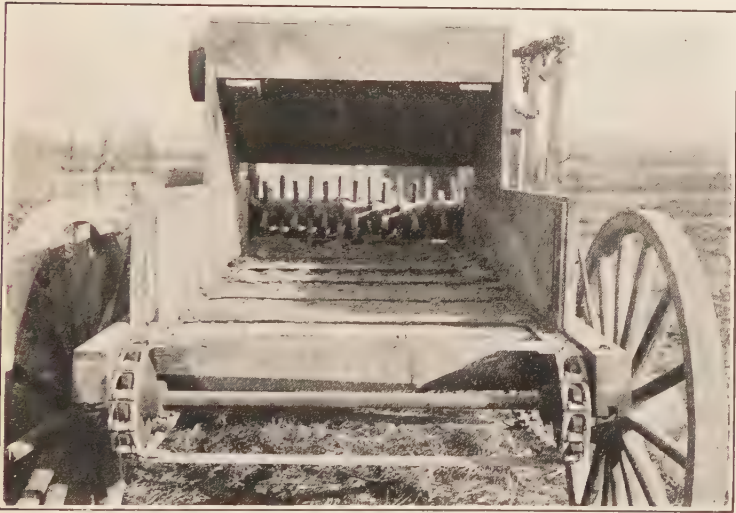


PLATE IV.—Upper. Compost pile. This is made up of alternate layers of sod and manure each about 6 inches thick; a small amount of lime is scattered on top of each layer of sod. The pile should be allowed to stand for at least 12 months before using. The horse-drawn machine is for mixing and pulverizing the material.

Lower. Rear view of the machine for pulverizing and thoroughly mixing compost materials.

CHAPTER V

LIME AND ITS USE

THE greatly increased use of lime by American farmers in recent years is one of the most striking facts in the agriculture of the day. The use of this substance on most soils in the eastern half of the United States is necessary if one wishes to grow alfalfa, and it is very efficient in promoting the growth of red clover. To a much less but to an appreciable extent, it is helpful to most of the ordinary farm crops such as corn, wheat, and most legumes.

In former times botanists and agriculturists called certain plants, found commonly in calcareous soils, lime-lovers or calciphiles; while other plants such as rhododendrons, which rarely thrive in the presence of lime, were called lime-haters or calciphobes. Most plants show no such marked relation to lime. However, calcareous soils are noted for their fertility, that is, their ability to produce large yields of ordinary farm crops.

In recent times the idea has prevailed largely that lime acts mainly in an indirect way, through its alkalinity. Most soils in humid regions are acid according to certain tests, but by the addition of lime they become neutral or slightly alkaline. It is this acid or alkaline condition which is held to be the important factor in affecting plants.

One effect of lime about which there is ample proof is that it greatly stimulates the activity of the nitrifying bacteria in the soil, and thus provides more nitrogen for growing plants. It is doubtless on this account that the effects of lime are always most marked on soils rich in humus and always slight on soils poor in vegetable matter.

Practically it matters but little whether lime acts directly or indirectly in its effects on plants. So far as the turf plants are concerned, experiments show that but few are much affected by its use. Kentucky Blue-grass is greatly stimulated by lime, White Clover and Bermuda-grass considerably. The bents and the fescues are not much affected by lime on most soils, and this is also true of many other turf grasses. The relative indifference of Creeping Bent, Rhode Island Bent, and Red Fescue to lime deserves especial comment, because these

three are the most important putting-green grasses in the North. As putting-greens must of necessity be kept highly fertilized, there is no object in using lime to increase nitrification in the soil. Use of lime, however, does stimulate any Blue-grass or White Clover that may be in the green, and there is ample evidence to show that it tends to encourage several of the troublesome weeds. For these reasons, the use of lime on putting-greens composed of the above grasses is probably not advantageous except in rare cases. The slightly more vigorous growth which lime may induce does not compensate for the undoubted increase of weed trouble.

On the fairways there is no reason to doubt the excellent effects of lime where the turf is composed largely or mainly of Blue-grass and White Clover, or in the South of Bermuda-grass. If, however, the turf is composed of Redtop, Creeping Bent, or Red Fescue, lime is not necessary, and its use cannot be expected to show satisfactory results.

It is a common belief that the presence of certain plants indicates a sour condition of the soil and the need of applying lime. Sheep sorrel is perhaps the commonest weed that is supposed to indicate acidity, but it seems probable that this

idea is based on the acid taste of its leaves. At any rate, sheep sorrel thrives well in soils rich in lime. Mosses and lichens in the turf are also supposed to indicate the need of lime, but when the evidence is weighed it is not very satisfactory.

It must be admitted that there is yet too small a body of data about the effect of lime on each kind of grass turf to warrant final conclusions. In most cases it would pay greenkeepers to test the effect of lime on a small plot of turf before using it largely. The instances are probably rare on golf courses where lime has had any serious detrimental effects, but on the other hand it is doubtful whether any really beneficial effects have been secured except with Kentucky Blue-grass and Bermuda-grass.

CHAPTER VI

THE IMPORTANT TURF PLANTS

IN growing turf one is in reality cultivating a particular grass or a mixture of grasses. It is manifest that to secure the best results detailed knowledge of each grass is necessary. Too often the sowing of a mixture is a frank acknowledgment of lack of knowledge, and this method is adopted in the hope that one of the grasses may succeed even if the others fail. To that extent it is justifiable, but as a rule one cannot hope to secure the best results if the grasses in the mixture make unlike qualities of turf or require different methods of treatment. In a few cases mixtures seem not only warranted but desirable. But in such cases there are definite reasons for using mixtures and not merely the hope that one may succeed if the other fails. While there is yet much to be learned about every turf grass, there already exists a large body of knowledge upon which a rational mixture can be based. Too often the mixtures used depend primarily upon what a

seedsman or a fertilizer dealer may advise, albeit in each case the advice comes from a man who has something to sell and naturally advises what he has to offer. There is no mystery about the sources of grass seeds nor of methods of recleaning them, even if it is undeniable that some seedsmen are more careful in recleaning their seeds and more reliable in their statements than are others. There is still much of mystery regarding the relative efficiency of fertilizers under different conditions, but the problems of fertilizers are so complex that one should always test a new fertilizer in a small way first before accepting it in place of another that has given satisfactory results.

The important turf grasses are discussed in detail. The finest species for putting-greens are Creeping Bent, Velvet Bent, Rhode Island Bent, and Red Fescue. Somewhat coarser grasses often used for putting-greens but more suitable for fairways are Kentucky Blue-grass, Redtop, Bermuda-grass, and Carpet-grass. Other turf plants that are discussed briefly are Japan Clover, Yarrow, Yellow Oat-grass, Crested Dogstail, Italian Rye-grass, Perennial Rye-grass, Annual Blue-grass, Korean Lawn-grass, Manila-grass, Mascarene-grass, White Clover, Canada

Blue-grass, Sheep's Fescue, Various-leaved Fescue, and Fine-leaved Fescue.

KENTUCKY BLUE-GRASS (*Poa pratensis*)

Kentucky Blue-grass (Fig. 2) is the most common turf and pasture grass in the northern half of the United States, over most of which area it comes in spontaneously. The botanical and traditional evidence both leave scarcely room to doubt that it is not native to the United States, but was introduced from Europe. Other names by which it is known or has been known



FIG. 2. — Kentucky Blue-grass (*Poa pratensis*): *a*, spikelet; *b*, floret, showing tuft of hairs at base.

are June-grass, Meadow-grass, Spear-grass, Spire-grass, and, in Virginia, Greensward. In this country most of these names are obsolete, or nearly so, the grass being known almost wholly as Kentucky Blue-grass or simply as Blue-grass.

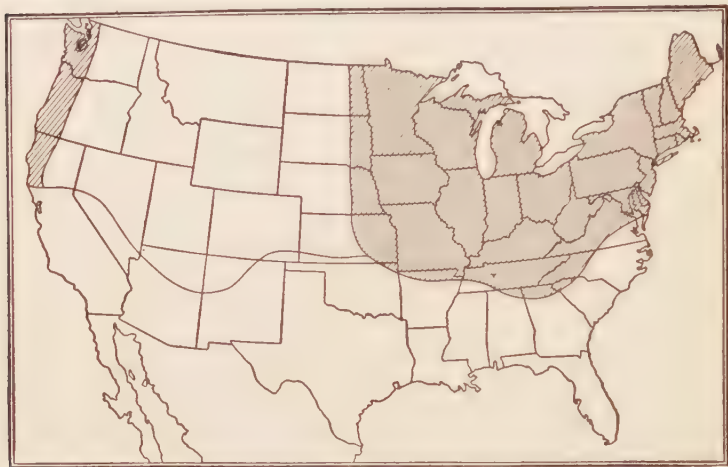


FIG. 3. — Map showing the areas in which Kentucky Blue-grass thrives best.

The name Blue-grass as applied to this grass is an unfortunate misnomer so far as the turf is concerned, which is a deep, vivid green. When in bloom the flowers do have a bluish or rather purplish cast, which perhaps gave rise to the name.

The accompanying map (Fig. 3) shows the area in which Blue-grass occurs abundantly. This area corresponds closely to that of the soils formed in the

southern movement of the great ice sheets in the glacial epochs. South of the glacial soils, Blue-grass is abundant only in limestone areas, but it thrives in California under irrigation, and in the cotton regions occurs in the hilly sections more or less commonly.

Kentucky Blue-grass is unique among our turf grasses in that it shows a strong predilection for limestone soils. It is due to this fact, combined with its nutritiousness, that the grass is so famous in the limestone districts of Kentucky, Tennessee, and Virginia. On the same reason is based the general practice of treating lawns with lime, as Blue-grass is the commonest grass used for this purpose. Unfortunately this has led to the general belief that all turf grasses are favored by lime, which is scarcely the truth. Occasionally excellent Blue-grass is found on land very poor in lime, but in such cases there is always good drainage.

Even when not in bloom Blue-grass may readily be recognized by its leaves. The leaf is about one-eighth inch wide, folded so as to be V-shaped in cross section, and the tip is boat-shaped, so that if it be pulled between the thumb and finger, a very noticeable split will be formed at the point. The only other

turf grass likely to be confused with Kentucky Blue-grass is Annual Blue-grass, but this has only fibrous roots and lacks the rootstocks of the former grass.

Kentucky Blue-grass is very variable, and many strains differing to a slight degree may easily be selected. Occasional tufts are very dense and fine-leaved.

Kentucky Blue-grass is an ideal grass in the North for fairways, and not rarely putting-greens are made up largely or almost wholly of this grass, especially where lime is used as a fertilizer. For putting-greens, however, it is not as fine as Creeping Bent or Red Fescue, but a good green of Blue-grass gives a fairly satisfactory putting surface.

Excepting in the northern tier of states, Blue-grass languishes during midsummer, as it is not adapted to withstand high temperatures. With the advent of cool weather in autumn, however, it generally recovers, even where a dense growth of Crab-grass has covered it during summer and early fall.

Commercial seed of Kentucky Blue-grass is produced in a few counties of Kentucky, Missouri, and Iowa, the greatest part of it from the first mentioned state, especially about the cities of Lexington, Winchester, and Paris. The seed is gathered by special

stripping machines, as the tuft of hair at the base of the seed makes other methods unsatisfactory. The stripping is done before the heads are quite mature, on which account the seeds must be dried very carefully, as otherwise they become injured by the spontaneous heating which occurs in the piles of the scarcely ripe seeds.

Blue-grass seed germinates better a year after it has been harvested than when fresh. Good seed should have a dark golden brown color, and be free from dust or musty odor. Light color indicates adulterated or mixed seed, while the presence of dust or musty odor implies improper curing and consequent low vitality. The best seed weighs twenty-eight pounds to the bushel. Formerly it was much adulterated with Canada Blue-grass, but such practice has now largely ceased.

ANNUAL BLUE-GRASS (*Poa annua*)

Annual Blue-grass (Fig. 4) is a weedy little grass that often occurs abundantly in putting-greens, springing up in the fall and disappearing in early summer. Where it is once established, it volunteers year after year, and in shady places often forms an excellent lawn in the spring. It is rather easily recognized by its light,

bright green color, its soft texture, the tendency of the leaves to curl toward the center, and the



FIG. 4. — Annual Blue-grass (*Poa annua*): *a*, base of leaf showing ligule; *b*, tip of leaf.

fact that they are often crumpled near the base. No matter how closely it is clipped, it will produce blossoms, often next to the ground. These sometimes appear in fall and are always abundant in earliest spring. Most of the plants die by early summer, but in cool seasons a few will live over a year.

Annual Blue-grass is not always looked on with favor, but when abundant it makes excellent putting-greens especially in early spring, and southward in late fall and winter as well. On some

Creeping Bent greens, Annual Blue-grass seems to make up all the grass on the green in early spring,

but as it gradually disappears in summer the Creeping Bent quickly replaces it as a rule. Occasionally the Annual Blue-grass is so abundant and dense as to injure the other grass seriously, but such cases seem rare.

In the South Annual Blue-grass would be ideal as a winter turf for putting-greens, but unfortunately the seed is high priced and but little of it can be secured commercially. As a consequence, such putting-greens are found only where the Annual Blue-grass has been abundant enough to reseed the ground thoroughly.

CANADA BLUE-GRASS (*Poa compressa*)

In spite of its name, Canada Blue-grass (Fig. 5) is a native of Europe, but for many years has been abundantly established in Canada. The distribution of Canada Blue-grass in America is nearly the same as that of Kentucky Blue-grass, but it is most abundant in poor soils, especially when rocky or gravelly.

Canada Blue-grass is easily distinguished by various characters. The leaves are gray-green or bluish-green, rather tough in texture. The stems are compressed so as to be two-edged, and the

same is true of the abundantly produced rootstocks. The panicle is close and narrow, not loose as in

Kentucky Blue-grass.

The seeds lack the hairy appendage at the base found in Kentucky Blue-grass. In consequence the seed is much more easily harvested, and therefore sells at a much lower price. Most of the commercial seed is produced in southern Ontario. Formerly this was much used to adulterate Kentucky Blue-grass seed, but under stringent legislation this practice has largely ceased.



FIG. 5.—Canada Blue-grass (*Poa compressa*):
a, spikelet; b, a single floret.

Canada Blue-grass produces a very tough but not very dense or attractive turf. It is a useful grass on fairways in the

northernmost states, especially where the soil is thin, but on better soils is not as good as Kentucky Bluegrass or Redtop.

REDTOP (*Agrostis alba*)

Redtop (Fig. 6) is botanically closely related to Creeping Bent. It is, however, a decidedly coarser, larger grass with broader leaves and larger inflorescence. Single plants of Redtop grow to a height of two to three feet, with leaf blades one-eighth to one-fourth of an inch wide. It spreads by creeping underground rootstocks. When planted thickly, however, and kept closely



FIG. 6. — Redtop (*Agrostis alba*).

mowed, the leaves are smaller and the turf not particularly coarse. If, however, the plants be given a better chance to grow, as at the edges of a green, the coarser nature of the turf quickly develops. Even when the turf is kept closely cut, Redtop can readily be distinguished from either Creeping Bent or Rhode Island Bent by the longer ligule (Fig. 18).

Redtop is a remarkable grass, owing to the wide range of conditions under which it will thrive. It grows admirably in wet land or even in shallow water. In strange contrast it will resist drought as well or better than most other grasses. For poor soils Redtop has long been recognized as one of the best grasses. Its range of climatic adaptation is scarcely less noteworthy, as it succeeds well from Canada south to the Gulf.

Redtop is a grass of considerable agricultural importance, being utilized mainly on wet lands for hay and on poor uplands for either hay or pasture. Due to its wide agricultural use, commercial seed is grown in large quantity, mainly in southern Illinois. This seed is much cheaper than that of either Creeping Bent or Rhode Island Bent, and as it can be distinguished only by an expert, it has often been used as a substitute or an adulterant for the two bents.

Redtop is a very valuable grass for fair greens in the northern half of the United States, especially on soils poor in lime. Under such circumstances, it is much cheaper and just as satisfactory to grow Redtop as it is to lime the land to induce the growth of Blue-grass.

For putting-greens Redtop is rather too coarse to be desirable.

RHODE ISLAND BENT (*Agrostis vulgaris*)

Rhode Island Bent (Plate V) is the most abundant turf grass growing on well-drained lands in New England, and it is common west to Michigan and south to Maryland. Botanically this grass is quite indistinguishable from Creeping Bent except that it produces only short stolons or runners. It is not the same as any of the three forms mentioned under Creeping Bent. The evidence is quite clear that the grass is not native to America, in spite of its abundance in New England, but that it was introduced from Europe, probably from England.

At one time Rhode Island Bent was mistakenly supposed to be the same as Velvet Bent or Brown Bent (*Agrostis canina*), but this last grass is not only very different, but it has never been a commer-

cial grass seed. Furthermore, Velvet Bent is not aggressive under American conditions and nowhere has become a common grass. Rhode Island Bent seems to be a uniform strain and makes a slightly coarser, darker green turf than does Creeping Bent.

Partly due to an error, but mainly to fraud, Rhode Island Bent has long been driven from the market. In former times Rhode Island Bent was much esteemed in New England for both hay and pasture. It was also known as Fine Bent, Furze Top, and Redtop, but is very different from the coarser grass now known commercially as Redtop.

Two causes led to driving Rhode Island Bent seed from the market. First, Illinois Redtop seed was much cheaper, and even in New England produced much higher hay yields, as it is a larger and coarser grass. The seed also is so nearly identical with that of Rhode Island Bent that unscrupulous or not well-informed seedsmen sold one for the other. Agriculturally Redtop is the better grass, but for lawns or fine turf Rhode Island Bent is far superior. Second, the idea became established in the seed trade that Creeping Bent and Rhode Island Bent were identical. This idea, it is true, is not far wrong as to botanical species, but turfs of Rhode Island



PLATE V. — Rhode Island Bent (*Agrostis vulgaris*).

Bent and Creeping Bent are different in appearance even if the seeds are indistinguishable.

Rhode Island Bent thus lost much of its identity and reputation. It is scarcely inferior to German Creeping Bent for fine turf. Large areas of the grass in practically pure growth occur throughout New England and on Long Island. There is no good reason why large quantities of this seed should not be gathered to supply the American demand, as it is a grass of much value for fine turf.

CREEPING BENT (*Agrostis stolonifera*)

Unquestionably the finest commercial grass for putting-greens in the North is Creeping Bent. It makes a beautiful, dense, soft, velvety turf, very compact and smooth, the ideal for a perfect putting-green (Plate VI). It thrives best in regions of moist, cool summers. On the outline map (Fig. 1) is shown graphically the areas in which it may be grown.

It succeeds best in the eastern states north of the Potomac and Ohio rivers and especially well in New York and New England; also on the northwest coast. In the South it can be grown satisfactorily only in the cooler half of the year, namely, fall to late spring.

Creeping Bent seed all comes from south Germany, and as handled by seedsmen differs mainly in the degree to which it may have been recleaned. Certain weed seeds are commonly present, only a few of which are objectionable, namely, mouse-ear chick weed, veronica, sorrel, and plantain.

Occasional lots of Creeping Bent from Germany represent a trailing form of Redtop, which produces much coarser stems and leaves. This form of Redtop is not found in America, and probably comes from a different part of Germany than does the true Creeping Bent.

The seed is now most commonly sold under the name of Creeping Bent, but sometimes is catalogued as Fiorin-grass (also applied to Redtop), and True German Fiorin-grass.

The seed is gathered from the wild grass, and never gives a perfectly uniform turf from the fact that several strains or varieties are included. If a Creeping Bent putting-green three or more years old be carefully examined, four kinds of turf can usually be distinguished, namely: (1) Very dense circular mats with fine, pale green leaves and long ligules; (2) Similar, somewhat coarser, mats of a darker blue-green color; (3) Much like 2 but of a

brighter green color; and (4) Less compact turf that does not make circular mats but fills the spaces between the others. Number 1 is in reality Velvet or Brown Bent (*Agrostis canina*), the seed of which is very commonly harvested with Creeping Bent. The three other forms are varieties of Creeping Bent, and when grown as separate plants produce runners one to six feet long which root at each joint. The three forms differ only in color and the compactness of the turf they form.

There has been much confusion about the botanical identity of Creeping Bent, albeit there is none about its commercial origin. Creeping Bent belongs to a group of grasses that are extraordinarily difficult to distinguish critically one from another, among them being those commercially known as Redtop and Rhode Island Bent. Creeping Bent, as pointed out, has at least three distinguishable kinds of turf, but the adult plants seem properly referable to the species known as *Agrostis stolonifera*, the name usually adopted in the trade. The three strains are not more different than similar strains that exist in most other grasses.

The existence of these three strains, however, keeps Creeping Bent turf from being entirely uni-

form. Another slight objection is the fact that the older leaves in dying turn brown and persist for some time, so that there is often a brownish background to the green in close-cut turf.

The seed was formerly much adulterated with that of Redtop, the seeds of the two being so nearly identical that only an expert can distinguish them. This fraud is now seldom practiced, but it is well to purchase only from reliable seedsmen who are in position to guarantee the seed. The individual seeds are very small, one pound containing about 6,000,000.

Creeping Bent is but slightly affected by lime, and it is very questionable whether lime should ever be applied where this grass is desired. Lime stimulates Blue-grass and White Clover, as well as various weeds, all of which on limed soils tend to crowd out the Creeping Bent.

Creeping Bent should be sown alone, as other grasses do not blend with it and most of them are coarser. There is perhaps one exception to this statement; namely, that Red Fescue and Creeping Bent together are often very satisfactory, at least for two or three years while the grasses are intermixed. In time, however, each grass will make cir-

cular mats which spoil both the appearance of the turf and its putting quality, as the stiff, wiry leaves of Red Fescue make quite a different putting surface from the soft leaves of Creeping Bent.

VELVET BENT OR BROWN BENT (*Agrostis canina*)

Velvet Bent makes the finest and most beautiful turf of any northern grass yet known. The grass is native to Europe, but has never been handled pure in the seed trade. The seed is nearly always found in Creeping Bent, sometimes to the extent of 40 per cent of the whole.

On any putting-green of Creeping Bent three years or more old, the circular mats made by Velvet Bent may readily be identified by the very dense, fine leaves and the rather pale apple-green color. By using a lens it will also be seen that the ligule is long and the surface of the leaves minutely roughened.

For some strange reason the fact that Velvet Bent makes such exquisite turf has been overlooked, but efforts are now being made to establish the seed commercially. Rhode Island Bent has erroneously been advertised by seedsmen as *Agrostis canina*, and the frauds which have surrounded the handling

of Rhode Island Bent seed have probably had much to do with causing the neglect of Velvet Bent. The name Brown Bent is in allusion to the color of the flower and not of the turf. Putting-greens of pure Velvet Bent would be far superior in beauty and fineness to the best greens now in existence, but only actual experience will determine whether they could be maintained as well as those of Creeping Bent.

RED FESCUE (*Festuca rubra*)

Red Fescue (Fig. 7) is next to Creeping Bent and Rhode Island Bent the most desirable grass for northern putting-greens. It is particularly adapted to growing on sandy loams but succeeds well on clay loams or even on clays. On the sandy types of soil it is to be preferred to the bents, especially in New England and the northern tier of states. Red Fescue is almost indifferent to lime, and this substance need not be used where this grass is desired. The grass is also remarkably adapted to growing in shade, being in fact the best lawn grass for this purpose under American conditions.

Red Fescue is native to the whole northern hemisphere, and is particularly abundant near the seacoast. In Europe there are numerous varieties, dis-



FIG. 7. — Red Fescue (*Festuca rubra*): *a*, top of sheath and base of blade; *b*, cross-section of leaf; *c*, the same as expanded on the upper leaves.

tinguished in part by the color of the herbage which varies from dark green to a pale glaucous green.

Like all the fescues, Red Fescue has stiff leaves, which give it a characteristic feeling if the palm of the hand is passed over the turf. The lower leaves persist a long time when dead, so that close-cut turf often has a reddish brown background. It is the only one of the fine-leaved fescues that will make a dense continuous turf.

Two varieties of Red Fescue occur in the trade, namely, Genuine or Creeping Red Fescue (*Festuca rubra* var. *genuina*), of which a small amount of seed is gathered in Germany; and New Zealand or Chewings' Fescue (*Festuca rubra* var. *fallax*). Creeping Red Fescue has slender rootstocks by which it spreads, so that a single plant may in time occupy an area six feet in diameter. The small amount of commercial seed that may be obtained is, however, much mixed with Sheep's Fescue and various weeds. Chewings' or New Zealand Red Fescue is a pure variety distinguished by its dark green color and the absence of creeping rootstocks, but the branches are extravaginal so that a single plant will spread to be a foot in diameter, and the grass will make a solid compact turf. This grass was introduced into

New Zealand from Germany about 1880 and for a time was very popular as a pasture plant, the seed having been harvested and sold first by a farmer named Chewings. At the present time it is used in New Zealand mainly on poor or thin soil, as other pasture grasses yield more on good soil. The New Zealand seed averages about twenty-four pounds to the bushel, but the best will weigh about twenty-six pounds. In well-cleaned commercial samples there are but few weed seeds, the only objectionable ones being Velvet Grass and Sheep Sorrel. The seed is often very low in viability, so that heavy seeding is necessary.

The dark green strain of Creeping Red Fescue makes probably the most beautiful lawns of any grass. In the turf experiments conducted by J. B. Olcott at South Manchester, Connecticut, all of the grasses were propagated by division so as to secure absolute uniformity. The most beautiful of the numerous turfs he grew was a dark green strain of Red Fescue. His lawns of this were probably the most beautiful lawns ever grown anywhere. In 1912, Fred W. Taylor, of Philadelphia, purchased this turf and about his home "Boxly" constructed his lawns of this grass. In spring and early summer

and again in late fall these lawns are unquestionably the most beautiful that exist. Unfortunately, how-

ever, in the latitude of Philadelphia this strain of Red Fescue in pure growth suffers from the attacks of a fungus disease, so that in midsummer the attractiveness of the turf is much lessened.



FIG. 8. — Sheep's Fescue (*Festuca ovina*): *a*, glumes at base of spikelet; *b*, spikelet.

SHEEP'S FESCUE (*Festuca ovina*)

Sheep's Fescue (Fig. 8) is native in the northern parts of the Old World, and apparently to a limited extent in

North America. Commercial seed is produced wholly in Europe, and it is the cheapest of the fescues. The

grass is useful agriculturally for planting on well-drained soils, especially those too poor to produce better pasture grasses. It thrives well both on sandy soils and on thin, rocky hills.

The grass is a bunch-grass, forming small tussocks four to eight inches in diameter, and usually separated by spaces equally wide. Under no circumstances will it alone form a good turf, as there are no creeping stems, but on rich soils the tufts may be made to grow close together. While often used in mixtures for the fairways, this is never advisable, as it is not needed where creeping grasses will thrive, and if planted alone it gives a bunchy sward with objectionable cuppy lies for the ball between the tufts.

The only desirable place for Sheep's Fescue on golf courses is in the rough, and especially where the soil is thin or sandy.

HARD FESCUE (*Festuca duriuscula*)

Hard Fescue is merely a variety of Sheep's Fescue with stiffer, broader leaves. Everything concerning the use of Sheep's Fescue on golf courses applies also to Hard Fescue. Most of the Hard Fescue seed in the trade is in reality Sheep's Fescue.

FINE-LEAVED FESCUE (*Festuca capillata*; *Festuca tenuifolia*)

Fine-leaved Fescue is also a grass of European origin. The leaves are very fine and dark green, much like those of Red Fescue. When in bloom this fescue is very easily distinguished, because its flowers are devoid of awns.

Fine-leaved Fescue is a bunch-grass, the circular tufts being usually two or three inches in diameter, but sometimes larger. On this account it is not a desirable putting-green grass either alone or in mixtures. Like Red Fescue it will thrive well in the shade, but the Red Fescue with its creeping habit is far more desirable.

VARIOUS-LEAVED FESCUE (*Festuca heterophylla*)

This fescue derives its name from the fact that the stem leaves differ from the basal leaves in being broad and flat. It is native to Europe where all the commercial seed is gathered. The leaves are fine and dark green, and the grass is partly creeping in habit. It does best on a soil rich in humus. It is not a very satisfactory turf plant, however, and it is doubtful whether it has any place on American golf courses.

BERMUDA-GRASS (*Cynodon dactylon*)

Bermuda-grass (Fig. 9) is native to India and probably other parts of the Old World. In most parts of India it is known as doob, but in the southern portions as hariali. It became introduced into the United States before 1807, at which date it was already well established. The outline map (Fig. 1) shows the area where Bermuda will survive the winter, and in most portions of this area it is now abundant. While Bermuda is the most valuable pasture grass in the South, it is often troublesome as a weed on account of the difficulty of eradicating it from cultivated fields. It is often termed Wire-grass, especially in Virginia, and in California also bears the name of Devil-grass.

Bermuda-grass consists of numerous varieties which vary particularly in their degree of coarseness and in the presence or absence of rootstocks. Ordinary Bermuda-grass has abundant creeping underground stems, but in the variety known as St. Lucie-grass these are entirely absent, all the stems being above the ground.

Bermuda-grass will grow in all types of soil when well-drained, but shows a notable preference for

compact soils such as clays and clay loams. Bermuda-grass is also much favored by the presence

of lime; a fact particularly noticeable along the edges of shell roads.

In general, Bermuda is not abundant on the sandy coastal soils of the South, Carpet-grass replacing it in large measure. There is reason to believe, however, that the use of lime would greatly increase its value on such soils.



FIG. 9. — Bermuda-grass (*Cynodon dactylon*): a, spikelet; b, floret.

For ordinary lawns and fairways Bermuda-grass is most excellent during summer, but it turns brown

with the first heavy frost. By sowing Italian Rye-grass on top of the close-clipped Bermuda turf in fall, a good green lawn can be made for the winter. In the early summer after the Bermuda is growing vigorously, the Rye-grass disappears. This same method can be used on fairways to advantage, but few southern golf courses have thus far followed this plan, though commonly used in lawns.

Bermuda putting-greens have in general not been altogether satisfactory, but a very notable exception is found in the greens of the Country Club at Montgomery, Alabama, developed by John M. Inglis. The excellent turf is apparently due primarily to the character of the soil, a heavy clay loam rich in lime. Heavy rolling to insure compact soil may also be important, as the close dense turf which occurs along paths and roadsides would seem to indicate. Inglis believes that the withholding of artificial watering is important.

The results secured at Montgomery make it seem probable that equally good putting-greens may be secured in the sandy soil area by using a top layer of clay soil a few inches thick and by applying lime generously.

On many putting-greens the creeping runners of

Bermuda make an uneven putting surface; but at Montgomery this difficulty does not occur. It is evident that for the best results a method must be used that will not induce the development of runners. In this connection several things are worthy of trial, namely, a clay surface soil, lime, moderate watering, and light fertilizing. It is not yet clear whether the growth of runners is stimulated by favorable conditions or by unfavorable, but the evidence indicates that on a rich well-limed compact clay loam soil a dense turf of Bermuda does not tend to produce runners, while on sandy land the growth is thinner and the runners are produced abundantly.

Another hope lies in finding a variety of Bermuda that is fine in texture and which does not form creeping stolons. If such a form can be found, it may easily be kept pure by vegetative propagation.

Bermuda may be grown either from seed or vegetatively from the turf. Commercial seed is produced both in Australia and in Arizona, the latter being preferable. The seeds are very small so that in sowing it is best to mix with double the quantity of some inert substance like sand, cottonseed-meal, and the like, by which means the seed can be scattered much more evenly.

In propagating Bermuda vegetatively, the sod or rootstocks should be in small pieces, if convenient cut up by putting through a feed-chopper. These pieces can then be scattered over soil with a loose surface and pressed in with a roller. This can be done at any time during the growing season. With a reasonable amount of moisture, nearly every piece of turf or rootstock will root and grow.

Where Bermuda is used for putting-greens, Italian Rye-grass is sometimes sown on the greens as soon as the Bermuda browns in fall. Italian Rye-grass grows very rapidly and soon forms good turf which will remain green all winter. For putting, however, Italian Rye-grass is coarser than is desirable. Red-top for winter greens should be fairly satisfactory, but thus far it seems not to have been utilized. An ideal grass for the purpose is Annual Blue-grass, but unfortunately the seed of this is rarely procurable. Where once well established this grass will usually reseed itself each year. Bermuda turf when thick will kill out all other perennial grasses where it grows, so that if Redtop or Italian Rye-grass is used as a winter green, it must be sown each fall.

On fairways that are not to be used in the summer, the Bermuda sod can be greatly invigorated if desir-

able by plowing or disking once during the period when the course is not being used, preferably in spring or early summer.

In the northern part of the region where Bermuda-grass will survive the winter, and in particular the area north of the southern boundaries of Virginia and Tennessee, it can scarcely be recommended for golf courses. In this area excellent fairways can be maintained with Blue-grass, Redtop, and White Clover, grasses which are green nearly all of the year. Bermuda-grass under such conditions forms unsightly brown spots in the sward in late fall and early spring, and has no compensating advantages. Besides there is danger of the grass finding its way to the putting-greens, where it is wholly undesirable if the greens are of finer grasses.

BLUE COUCH-GRASS (*Syntherisma didactyla*; *Digitaria didactyla*)

Blue Couch-grass is a native of Australia much used for lawns in that country. In habit it is not unlike St. Lucie-grass, a variety of Bermuda-grass, but the leaves are decidedly bluish in color. From preliminary experiments it seems well adapted to the southern states, and it may prove more desir-

able for turf than Bermuda-grass. It is propagated vegetatively as described for Bermuda-grass. It is not to be confused with Quack-grass or Witch-grass, commonly called Couch-grass in some sections.

CARPET-GRASS

(*Axonopus compressus*)

Carpet-grass (Fig. 10) occurs spontaneously south of latitude 32° to the Gulf and as far west as Texas. The grass is a perennial with creeping rootstocks and numer-



FIG. 10. — Carpet-grass (*Axonopus compressus*).

ous short, rather broad, flat, blunt-pointed leaves. The stems are compressed so as to be two-edged, and the slender flowering branches are one to two feet high.

Carpet-grass prefers sandy land, especially where moist, and in such situations makes a fine dense sward. It stands trampling and pasturing without injury and seems to thrive best under such conditions.

Carpet-grass can scarcely be considered a cultivated grass, and commercial seed is seldom obtainable. This grass now occurs in nearly all the area to which it is adapted, so that it is rarely necessary to plant it especially. Where this is desirable, however, Carpet-grass may be planted by scattering small pieces of sod, as in the case of Bermuda-grass. Or better, the grass may be permitted to seed, mowed when mature, and the straw with the attached seed scattered over the field where it is desired.

Carpet-grass is rather too coarse for putting-greens, but for fairways is an excellent turf grass. Near the Gulf Coast it is green from April to November.

CRESTED DOGSTAIL (*Cynosurus cristatus*)

This is a European grass that is very poorly adapted to American conditions, so that it is a rare plant in the United States. On European golf

courses it is used to some extent, especially on tees, as the tough turf holds the ball up well.

For some unfounded reason it is an element in many of the seedsmen's mixtures advertised for use on putting-greens in America. Even if the grass would thrive in this country, it does not make a turf comparable in fineness with Red Fescue or the bents. Its use in the United States, except perhaps in the western portions of Oregon and Washington, is a mistake.

YELLOW OAT-GRASS (*Trisetum flavescens*)

Yellow Oat-grass is a native of Europe used in pasture mixtures. Commercial seed is gathered in France. Plants of it are occasionally found in putting-greens, and are easily recognized by the pale color and hairiness. The turf is fairly good, but soft and slow, so that it is not to be recommended. It is not an aggressive grass under American conditions.

ITALIAN RYE-GRASS (*Lolium multiflorum* or *Lolium italicum*)

Italian Rye-grass (Fig. 11) is a native of Europe, much used there for hay production, and to a small extent in a similar way in the United States. The

grass is a short-lived perennial, usually treated agriculturally as a winter annual. It is a common

constituent of lawn mixtures, primarily, because the young seedlings grow so rapidly and make a green cover while the slower growing grasses are becoming established.

For golf purposes, it has no place except to sow on Bermuda turf in the fall as the latter becomes brown. Used this way it will make a good green fairway for the winter.



FIG. 11. — Italian Rye-grass (*Lolium multiflorum*).

It has also been used in this manner for putting-greens, but is rather too coarse, Annual Blue-grass and Redtop being preferable for this purpose.



FIG. 12. — Perennial Rye-grass (*Lolium perenne*): *a*, top of sheath, base of blade and ligule; *b*, cross-section of leaf-bud to show manner of folding.

PERENNIAL RYE-GRASS (*Lolium perenne*)

This grass (Fig. 12), also known as English or Australian Rye-grass, is in general much like Italian Rye-grass, save that it is perennial, living several years. For golf purposes it has no higher value than Italian Rye-grass, and its initial growth is not so rapid. Perennial Rye-grass seed is sometimes put by seedsmen in putting-green mixtures, but the turf it forms is too coarse to be desirable. On fairways it is not objectionable, but there are few conditions under which other grasses are not more desirable, excepting where a turf is desired quickly.

KOREAN LAWN-GRASS (*Zoysia japonica*)

This grass (Fig. 13) was introduced into the United States many years ago from Korea. In a general way it is comparable to Bermuda, but is far less aggressive than that grass. It will survive the winter as far north as Connecticut. For putting-greens it may prove desirable on sandy soils from North Carolina southward, but there is yet need of much experimenting to determine this point. Very beautiful turf of this grass is growing at Miami, Florida. It is also known as Palm Beach-grass.



FIG. 13. — Korean Lawn-grass (*Zoysia japonica*).

MANILA-GRASS (*Zoysia matrella*)

Manila-grass is native to the Philippines and other places in the Malayan region. In Manila it makes the very fine and beautiful turf seen on the Luneta. In experimental trials along the Gulf Coast of the United States this grass has formed very beautiful

plots of fine-leaved turf, which remains green all winter. The texture of the turf would make it ideal for putting-greens, and there is hope that this grass may be exactly what is desired for Gulf Coast and Florida golf courses.

MASCARENE-GRASS (*Zoysia tenuifolia*)

This grass was originally found in the Mascarene Islands, but was introduced into the United States in 1912 from Guam. It differs from the other *Zoysias* in having very short, stiff leaves and makes a beautiful turf much like Red Fescue. Underground it produces an enormous quantity of short rootstocks which keep elevating the turf in ridges, a defect that probably could be controlled by proper rolling. Both in California and along the Gulf Coast, plots of this turf succeed well, but it has not yet been tested for golf purposes. It remains green all winter on the Gulf Coast.

JAPAN CLOVER (*Lespedeza striata*)

Japan Clover or Lespedeza (Fig. 14) is an annual clover-like plant introduced into the United States about 1846. It is native to western Asia and undoubtedly became introduced into America by acci-

dent. There still exists a dried specimen of the plant collected by T. C. Porter at Monticello in central Georgia in 1846, which is the first definite record of the plant in America. In the South the opinion exists in many places that the plant was first introduced during the

Civil War. Doubtless the plant was greatly spread during that struggle by the movements of cavalry. On the accompanying map (Fig. 15) is shown the outline of the area over which Japan Clover has become established, and also the probable



FIG. 14. — Japan Clover (*Lespedeza striata*). A young seedling and the tip of a mature branch.

area to the northward over which it can profitably be seeded on fair greens.

Within the limits indicated on the map, Japan Clover persists where once established, reseeding itself each year. In the lower Mississippi Valley

on rich land it sometimes grows two feet high and makes heavy crops of valuable hay. On poorer land, and towards its northern limits, it grows only two to six inches high, and is valuable mainly for pasturage. If closely pastured or frequently mowed, it makes a good turf from early summer until killed by frost. A single plant will often make a dense mat six inches in diameter. Throughout the South lawns and pastures usually contain a considerable percentage of Japan Clover, and it blends well in color with the grasses.

Japan Clover is remarkable for its ability to grow on very poor soils. This makes it invaluable on many golf courses where the soil is poor, as during the summer such spots become thickly carpeted with Japan Clover. The young plants usually appear in the latitude of Washington, D.C., about May 1, and by June have made a dense covering. It can be closely clipped without injury, and makes an ideal lie for brassey shots. Where, however, the plant is kept closely clipped, it can form but little seed and so will disappear in a few years unless reseeded.

The season north of the limit shown on the map (Fig. 15) is not long enough to enable Japan Clover to reseed itself naturally, but the plant assists ma-

terially for three or four months. Japan Clover is practically the only plant available for sowing on fair greens in spring with the assurance that it will improve the turf the same season, no matter how poor the soil may be. It can be made almost

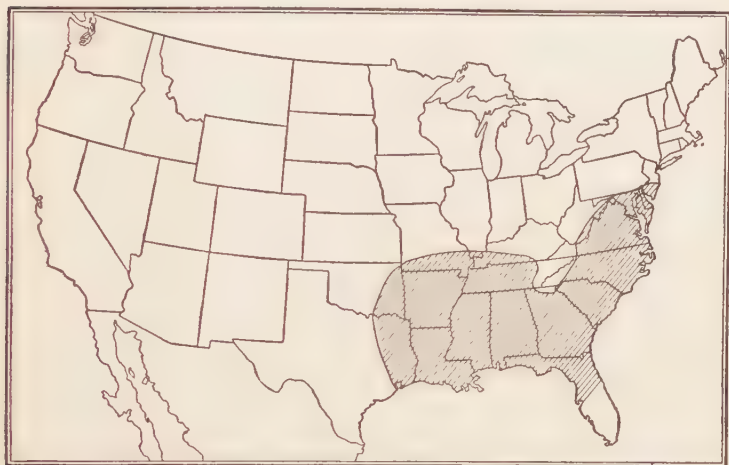


FIG. 15. — Outline map of United States showing area adapted to Japan Clover; north of the cross-hatched area it does not reseed itself.

as valuable on golf courses in the North as in the South — only it must be sown every year in the North.

Japan Clover should never be sown before the ground is well warmed; that is, about corn planting time. Under natural conditions the seed falls on the ground in fall and germinates in late spring,

but stored seed usually sprouts promptly if planted when the weather is warm enough.

Seed of Japan Clover is now commercialized and can be purchased in any quantity at reasonable prices either hulled or unhulled. It is handled by all southern seedsmen.

In the North it should be seeded rather thickly so as to secure a thick stand of turf quickly. Its ability to grow on the poorest and hardest soil is such that no previous treatment of the land is necessary, but if sown on thin slopes it may wash down during heavy rains. On such places, therefore, the soil should be scratched or the seed covered with a little soil. Where the turf is bunchy, Japan Clover is one of the best plants to fill in the cuppy interstices. Heavy seeding is desirable, about one bushel to the acre where turf is thin.

It still remains to be determined just how far northward Japan Clover can be used with satisfaction on golf courses, but with little doubt it will be found valuable at least as far north as indicated by the limit on the map (Fig. 15). Its very high value as far north as the southern line of Pennsylvania, where it persists naturally, leads to the conclusion that it will be valuable much farther north. Until

this is fully determined, however, only experimental trials are advisable on golf courses where it would be likely to be helpful.

WHITE CLOVER (*Trifolium repens*)

White Clover is so well known as to need no description. Though native to Europe, it is common over nearly all parts of the United States. It is most abundant in the northern half of the country, but plentiful enough in the South. White Clover is very frequently used in lawn mixtures, but on golf courses is not usually welcomed. The plant spreads naturally to such an extent that it nearly always finds its way into grass turf wherever planted. On fairways there seems no really valid objection to the plant, but for some reason golfers have acquired a prejudice against it. The good points of White Clover as a turf plant are its ability to grow on poor soil, to form a close, dense mat, and to withstand very close clipping well. The common criticism against it is that the leaves become crushed and make a slippery mass, but this objection is more fancied than real.

On putting-greens, White Clover is not desirable, although when closely clipped the turf permits of accurate putting. (Plate VII.) Scattered tufts of

White Clover are not uncommon on very good putting-greens, and are nearly always tolerated. On putting-greens, however, White Clover may be considered a weed, and if considered sufficiently objectionable its turf can be removed bodily and replaced by patches of whatever grass is being used on the greens.

YARROW (*Achillea millefolium*)

Yarrow or Milfoil is more often regarded as a weed than as a turf plant, especially when found on putting-greens. Nevertheless, it, like White Clover, is usually suffered to remain on a putting-green, even if its turf (Plate VII) is recognized to be inferior to the fine grasses. Yarrow is a deep-rooted perennial that makes a very tough persistent turf, a single plant sometimes covering an area three feet in diameter. A few golfers have seriously advocated its use for putting-greens, and in a few cases greens have thus been sown. Seed is obtainable from European seedsmen, as yarrow is often sown on thin land in mixtures for sheep pastures. The seed is very fine, containing 3,500,000 to the pound, and it is therefore desirable to mix with sand or other inert material when sowing.

CHAPTER VII

HOW TO DISTINGUISH DIFFERENT KINDS OF TURF

It is often desirable to know definitely what grass composes a particular piece or patch of turf. This question arises frequently, and it is amazing how diverse may be the opinions of men who ought to be familiar with the commoner turf grasses and their weedy competitors.

It is not particularly easy to distinguish the different fine grasses from the turf alone. At times even the expert is puzzled, and the tyro is more often wrong than right. There are, however, differences in the turf that in nearly every case permit positive identification. These differences are pointed out in the following descriptions and are illustrated by the accompanying figures.

Two keys are also presented by means of which one should readily identify the turf of any one of the sixteen grasses described. These grasses include all the most common fine turf grasses and a few of the coarser weedy grasses often found on putting-greens.

The two keys are presented because in one the first division is based on the presence or absence of rootstocks, a character not developed in very young plants.

Inasmuch as the descriptions and keys require the use of a number of technical botanical terms, these require some explanation.

The true roots of grasses are very slender, mostly vertical, and usually but sparingly branched. Apart from the erect stems that bear the flowers, grasses may have stems that creep on the surface and usually root at the joints. These are called stolons. Many grasses also have underground branches, called rootstocks or rhizomes. These differ from roots in being stouter, usually horizontal, jointed, and bearing scales or reduced leaves at the nodes.

The grass leaf consists of two principal parts, the sheath or tube-like portion that envelops the stem, and the blade, which is nearly always narrow and usually flat. The hinge-like place where the sheath joins the blade is termed the collar. In some species, like Italian Rye-grass, the edges of the collar project on the sides into flange-like appendages. In other grasses like Sheep's Fescue and Meadow Fescue each angle at the top of the sheath extends

into a projection, called an auricle. On the inside of the junction of the sheath and blade is a delicate organ, usually a thin membrane, termed a ligule. Sometimes the ligule is a mere fringe of hairs and in a few grasses is lacking. The character of the ligule is very helpful in identifying a grass. The sheath is usually cylindrical in form, but in many grasses is flattened or compressed. Many grasses are more or less hairy, but where hairs are absent the surface is called glabrous. Before the blade expands it may be folded in the bud like the two covers of a book; or it may be convolute, that is, rolled from one edge to the other into a tube. This may be seen by pulling off the outer leaves until the young inner ones are exposed; or by cutting across with a sharp knife and examining the cross-section. As the parts to be examined are rather small, a good lens is necessary to see clearly the characters necessary for identification.

Key to Identify Grasses in Turf

- A. Plants with rootstocks.
 - B. Ligule a fringe of hairs **BERMUDA-GRASS.**
 - BB. Ligule a small membrane.
 - C. Leaves stiff, bristle-like, sharp-pointed **RED FESCUE.**
 - CC. Leaves not stiff nor bristle-like.
 - D. Blades folded in the bud, the tip boat-shaped **KENTUCKY BLUE-GRASS.**
 - DD. Blades convolute in the bud, flat when expanded, not boat-shaped at tip.

- E. Ligule long; blades rather broad REDTOP.
- EE. Ligule very short; blades narrow CREEPING BENT.
- AA. Plants without rootstocks.
- B. Collar with appendages in addition to the ligule; blades shiny beneath.
- C. Appendage a sharp projecting point from the angle of the sheath on each side MEADOW FESCUE.
- CC. Appendage a flange-like projection on each side of the collar.
- D. Blades folded in the bud . . PERENNIAL RYE-GRASS.
- DD. Blades convolute in the bud . ITALIAN RYE-GRASS.
- BB. Collar without appendages in addition to the ligule.
- C. Blades bristle-like, stiff.
- D. Leaves pale bluish green . . SHEEP'S FESCUE.
- DD. Leaves bright green . . . FINE-LEAVED FESCUE.
- CC. Blades not bristle-like nor stiff.
- D. Leaves rather broad, convolute in the bud.
- E. Sheaths hairy; plants at length forming stolons . . CRAB-GRASS.
- EE. Sheaths glabrous; plants never forming stolons . . PIGEON-GRASS.
- DD. Leaves folded in the bud.
- E. Collar glabrous; blades narrow ANNUAL BLUE-GRASS.
- EE. Collar hairy; blades broad.
- F. Sheaths and blades hairy YELLOW OAT-GRASS.
- FF. Sheaths and blades not hairy.
- G. Plant forming stolons: ligule a fringe of hairs; tip of blade rounded . . CARPET-GRASS.
- GG. Plant not forming stolons: ligule a small membrane; tip of blade acute . . GOOSE-GRASS.

Another Key to Identify Grass in Turf

- A. Leaves convolute in the bud.
- B. Collar with appendages in addition to the ligule; blades shiny beneath.
- C. Appendage a flange-like projection on each side of the collar ITALIAN RYE-GRASS.

- CC. Appendage a sharp projecting point from the angle of the sheath on each side MEADOW FESCUE.
- BB. Collar without appendages in addition to the ligule; blades not shiny beneath.
- C. Sheaths hairy.
 - D. Ligule a fringe of short hairs BERMUDA-GRASS.
 - DD. Ligule a thin membrane CRAB-GRASS.
- CC. Sheaths not hairy.
 - D. Blades broad, hairy above; rootstocks none PIGEON-GRASS.
 - DD. Blades not broad, glabrous; rootstocks present in older plants.
 - E. Ligule long; blades $\frac{1}{4}$ inch wide REDTOP.
 - EE. Ligule short; blades $\frac{1}{8}$ inch wide CREEPING BENT.
- AA. Leaves flat or folded in the bud.
 - B. Collar with a flange-like projection on each side PERENNIAL RYE-GRASS.
 - BB. Collar without flange-like projections.
 - C. Whole plant soft hairy YELLOW OAT-GRASS.
 - CC. Whole plant glabrous or nearly so.
 - D. Collar hairy; blades broad.
 - E. Sheaths green; plant at length producing stolons; ligule a fringe of hairs CARPET-GRASS.
 - EE. Sheaths white near the ground; plants never producing stolons; ligule a thin membrane GOOSE-GRASS.
 - DD. Collar not hairy; blades narrow.
 - E. Blades stiff, bristle-like, sharp-pointed.
 - F. Plants creeping by rootstocks; leaves usually bright green RED FESCUE.
 - FF. Plants in tufts.
 - G. Leaves pale bluish green SHEEP'S FESCUE.
 - GG. Leaves bright green FINE-LEAVED FESCUE.
 - EE. Blades not stiff nor bristle-like, the tip boat-shaped.
 - F. Leaves pale green; rootstocks wanting ANNUAL BLUE-GRASS.
 - FF. Leaves dark green; rootstocks present KENTUCKY BLUE-GRASS.

Perennial or English Rye-grass (*Lolium perenne*). — A glabrous perennial grass without rootstocks; sheaths broad, reddish near and below the ground; blades shiny on the under side, folded in the bud; ligule short, blunt; auricle shaped like a claw.

Perennial Rye-grass is well marked by the shiny under side of the blades, the broad, reddish sheaths, and the folded bud leaves. (Fig. 12.)

Italian Rye-grass (*Lolium multiflorum*). — Annual

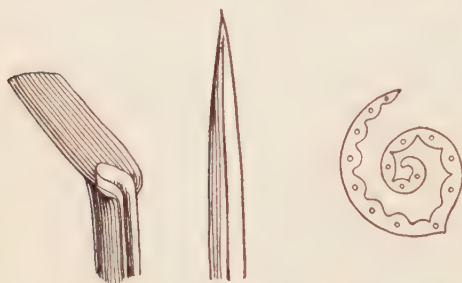


FIG. 16. — Italian Rye-grass (*Lolium multiflorum*), showing ligule, tip of leaf, and cross-section of rolled leaf-bud.

or short-lived perennial, distinguishable in the turf form from Perennial Rye-grass only by the blades being convolute in the bud. (Fig. 16.)

Kentucky Blue-grass (*Poa pratensis*). — Perennial, glabrous, dark green, spreading by creeping rootstocks; leaves folded in the bud, narrow, usually channeled above and boat-shaped at tip; ligule membranous, short. (Fig. 17.)



FIG. 17. — Kentucky Blue-grass (*Poa pratensis*), showing ligule and boat-shaped leaf-tip.

The dark green color and the peculiar apex of the leaf, which splits if the blade be drawn between the thumb and finger, usually identify this grass beyond question.

Annual Blue-grass (*Poa annua*). — Annual or rarely living more than one year, growing in small circular tufts, glabrous; leaves pale green, soft, often wrinkled at base; sheaths compressed; ligule membranous.

Annual Blue-grass is usually easily recognized by its pale green color; by appearing in late fall and early spring; and by blooming when only an inch or so high.

Redtop (*Agrostis alba*). — Perennial, glabrous, dark green, spreading by creeping rootstocks; leaves rolled in the bud, becoming flat, acute at tip; sheaths smooth, not compressed; ligule membranous, long. (Fig. 18.)

Creeping Bent (*Agrostis stolonifera*).

— Distinguishable in the turf from Redtop only by its short ligule and narrow leaves. Young Redtop is extremely like Creeping Bent, but as the plants become larger the broader leaves of Redtop become evident. (Fig. 19.)

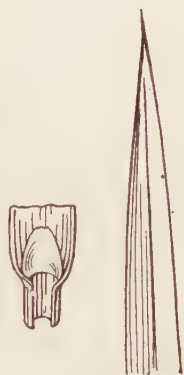


FIG. 18. — Redtop (*Agrostis alba*), showing ligule and leaf-tip.

Red Fescue (*Festuca rubra*). — A glabrous perennial with creeping rootstocks; leaves numerous, bristle-like, dark green; sheaths becoming brown and papery; ligule short, acute.



FIG. 19. — Creeping Bent (*Agrostis stolonifera*), showing ligule and leaf-tip.

Red Fescue may be distinguished at once from other bristle-leaved fescues by its creeping rootstocks.

Fine-leaved Fescue (*Festuca capillata*). — Perennial, glabrous, forming small dense circular tufts; blades very numerous, bristle-like, dark green. Distinguishable from Red Fescue by the absence of rootstocks, and when in bloom by lacking awns to the flowers.

Sheep's Fescue (*Festuca ovina*). — A perennial, glabrous grass growing in small circular tufts; leaves very numerous, bristle-like, stiff, sharp-pointed, pale bluish green; old sheaths persisting as dark fibers; ligule very short, membranous; auricles blunt. (Fig. 20.)

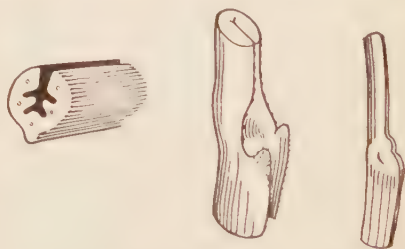


FIG. 20. — Sheep's Fescue (*Festuca ovina*), showing cross-section of leaf-blade, and blunt appendages at tip of sheath both on basal and on stem leaves.

Sheep's Fescue may be distinguished from all other common grasses by its stiff, bristly leaves and pale bluish green color.

Meadow Fescue (*Festuca elatior*).

— A perennial, glabrous, tufted grass ; leaf-blades convolute in bud, tapering at tip, shiny beneath, rough on the margins and with the nerves prominent on the upper surface ; ligule short ; upper angles of the sheath each bearing a sharp appendage. (Fig. 21.)

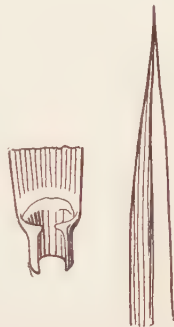


FIG. 21. — Meadow Fescue (*Festuca elatior*), showing short ligule, sharp appendages, and tip of leaf-blade.

Most likely to be confused with the rye grasses, but easily distinguishable by the sharp-pointed appendages on the sheath.

Bermuda-grass (*Cynodon dactylon*).

— Perennial, with both rootstocks and stolons, dark bluish green ; blades soft, flat ; sheaths compressed, sparsely hairy ; ligule a fringe of short hairs ; rootstocks thick and white. (Fig. 22.)

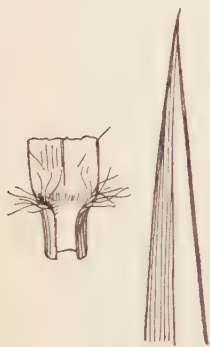


FIG. 22. — Bermuda-grass (*Cynodon dactylon*), showing the leaf-tip and the long hairs that replace the ligule.

The rootstocks and ligules of Bermuda-grass are characteristic.

Yellow Oat-grass (*Trisetum flavescens*). — A perennial, loosely tufted, pale green grass; sheaths and blades soft, hairy; blades folded in the bud, becoming flat, $\frac{1}{4}$ to $\frac{1}{2}$ inch wide; ligule a short obtuse membrane.

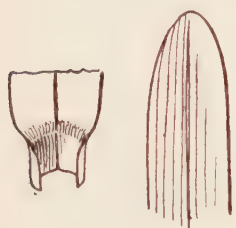


FIG. 23. — Carpet-grass (*Axonopus compressus*). Leaf-tip rounded and ligule a circlet of hairs.

Carpet-grass (*Axonopus compressus*). — A perennial grass with compressed stems creeping on the surface; leaf-blades $\frac{1}{8}$ to $\frac{1}{4}$ inch wide, 2 to 4 inches long, rounded at tip, folded in the bud, glabrous except a few long hairs near the base; sheaths much compressed; ligule a fringe of short hairs. (Fig. 23.) A common grass in the South, especially near the Gulf Coast.

Goose-grass (*Eleusine indica*). — Annual, in circular tufts; leaves sparsely hairy above, somewhat folded, about $\frac{1}{4}$ inch wide, acute at tip; sheaths strongly compressed, white near the ground, hairy along the margins; collar hairy; ligule membranous. (Fig. 24.) A common summer weed, often on putting-greens.

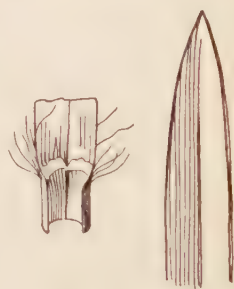


FIG. 24. — Goose-grass (*Eleusine indica*), showing ligule and leaf-tip.

Pigeon-grass (*Chætochloa lutescens*). — Annual weedy grass often found in putting-greens; leaves hairy on the upper surface, $\frac{1}{4}$ inch or more wide; ligule a fringe of short hairs. (Fig. 25.)

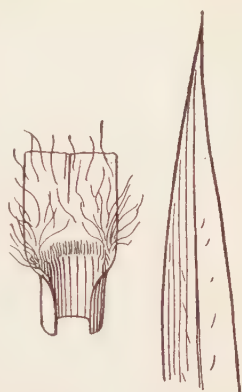


FIG. 25. — Pigeon-grass (*Chætochloa lutescens*), showing hairy blade, ligule or circlet of hairs, and broad leaf with acute tip.

Crab-grass (*Syntherisma sanguinalis*). — Annual, with at length branches creeping on the surface;

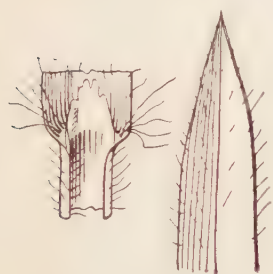


FIG. 26. — Crab-grass (*Syntherisma sanguinalis*), showing ligule, and hairy sheath and blade with acute tip.

leaves pale green, sparsely hairy, about $\frac{1}{4}$ inch wide; sheaths compressed, hairy; collar hairy; ligule membranous. (Fig. 26.)

Crab-grass may easily be distinguished from Pigeon-grass by the ligules; and from Goose-grass by the more hairy sheaths, and the convolute young leaves.

CHAPTER VIII

THE TURF GRASSES FOR DIFFERENT PURPOSES

Not all the grasses are equally adapted to the different parts of the golf course. One must be prepared to exercise a wise choice. Some of the main considerations in this choice require discussion.

GRASSES FOR PUTTING-GREENS

Although it has already been mentioned, it is well to emphasize strongly the particular grass seeds that should be sown for putting-greens.

Creeping Bent. — Creeping Bent makes the most nearly perfect turf for putting-greens in all localities north of latitude 38°, that is, roughly, the line of the Potomac and Ohio rivers. South of this line it is to be recommended only in the mountains. The principal requirements to grow this grass most successfully are rich soil and good drainage. Lime is not necessary and rarely, if ever, helpful to this grass.

Rhode Island Bent. — Rhode Island Bent differs



PLATE VI. — Turf of Crab-grass and Creeping Bent, natural size. The ball on the former serves to furnish an idea of the relative putting qualities of the two grasses.

from Creeping Bent mainly in being a little coarser and in creeping only slightly. It is of nearly equal value to Creeping Bent, but pure seed is rare on the market.

Red Fescue. — Red Fescue is a most excellent putting-green grass for the northern tier of states and southward in the mountains. In the lowlands southward it is not very satisfactory to use, except perhaps in mixtures. Red Fescue prefers well-drained soils and is indifferent to lime. It grows best on sandy soils but succeeds well on clays. The seed is often very low in germination.

Bermuda-grass. — For the South there is as yet known no thoroughly satisfactory grass for putting-greens. Bermuda-grass turf, if kept from producing runners, is, however, fairly satisfactory. To secure such result the following factors are apparently important: (1) A compact clay loam soil; (2) An abundance of lime; (3) Good fertility; (4) Moderate watering; (5) Close and frequent clipping.

MIXTURES FOR PUTTING-GREENS

To judge from the literature of prominent seedsmen, the most important factor necessary to secure

a perfect putting-green is the special seed mixture as prepared by each. If this were true, it would naturally follow that the putting-green mixtures produced by the different seedsmen would be practically identical as to composition, even if somewhat different in quality. As a matter of fact, the seedsmen's mixtures do differ, if not radically in the results they produce, certainly in the percentages of their important constituents.

Just what is the basis upon which these mixtures have been compounded is not clearly apparent, but they are not founded on critical experimental data, since no such data are actually in existence. It is true, there is a large amount of experience, recorded and otherwise, with all sorts of mixtures and with pure grasses, under very diverse conditions, but as yet few careful experiments have been conducted wherein various proportions have been critically compared under the same environment. Likewise, few critical experiments have been conducted for the purpose of comparing various grass mixtures with single species for putting-greens. The futility of adopting hard and fast proportions in grass mixtures is clearly shown by the results which the mixtures give when seeded.

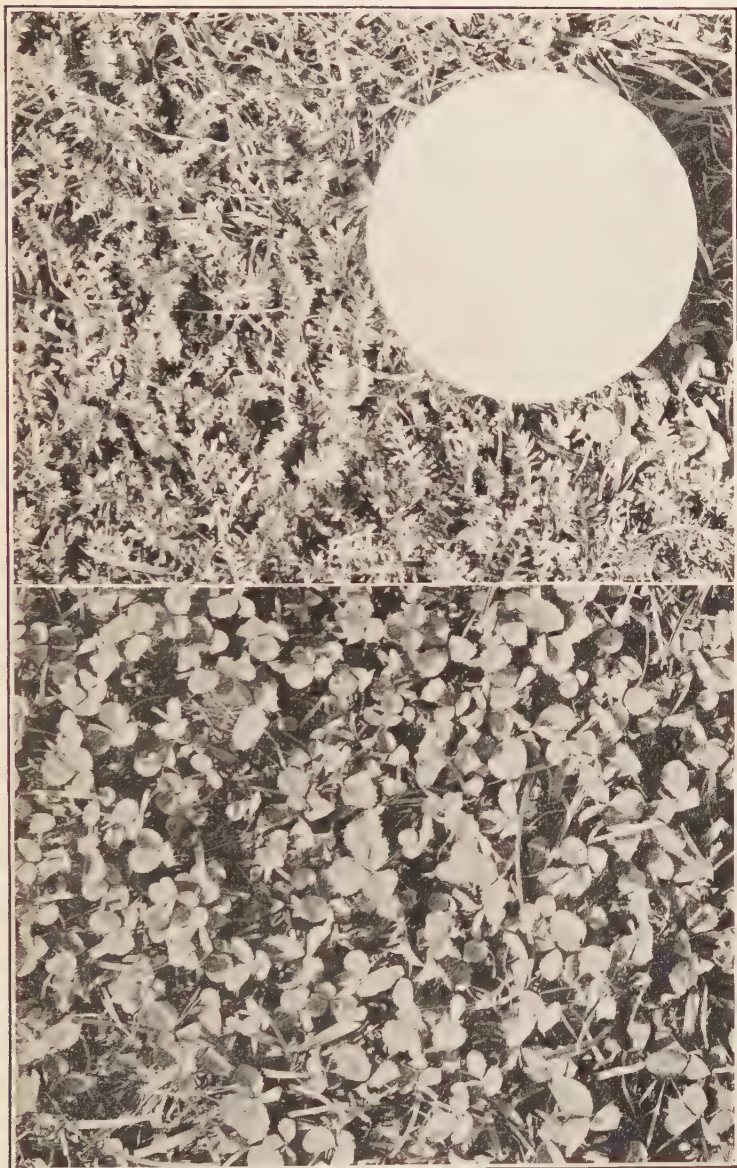


PLATE VII. — Turf of Yarrow and White Clover, natural size. A ball is located on the former.

For example, a lawn mixture very commonly used in the northern portion of the United States is composed of 16 parts by weight of Kentucky Blue-grass, 3 parts re-cleaned Redtop, and 1 part White Clover. When properly seeded, this mixture gives a very satisfactory lawn with the three component species all in evidence.

If the proportions are changed, it might naturally be supposed that an appreciable difference in the resulting herbage would develop. Such is only rarely the case, and after securing practically the same results from seeding widely different proportions of Blue-grass, Redtop, and White Clover, the conclusion is that the exact mixture idea is not well founded.

A careful examination of several much advertised putting-green seed mixtures reveals in a general way some of the fallacies upon which they are based. A table showing the estimated percentage by bulk of each constituent is given on the following page to illustrate a few important points.

It develops that the best advertised commercial mixtures are composed of *Festuca rubra*, in most cases Chewings' Fescue; *Agrostis* species, largely Creeping Bent; and Crested Dogtail. In one

case Crested Dogtail was absent, and in another there was a small percentage of Perennial Rye-grass. In number 2 the Creeping Bent was largely or wholly replaced by Redtop. It will be noted that there is a general agreement of proportions in mixtures 3 and 4, but a considerable difference between these and numbers 1 and 2, and between number 1 and number 2. For such a highly specialized purpose as the production of a putting-green, it would appear that some one had blundered, if the compounding of mixtures were really an exact proposition.

APPROXIMATE PERCENTAGE OF DIFFERENT SEEDS BY BULK IN
VARIOUS COMMERCIAL PUTTING-GREEN MIXTURES

KINDS OF SEED	MIXTURE No. 1	MIXTURE No. 2	MIXTURE No. 3	MIXTURE No. 4	MIXTURE No. 5
Fescue ¹	80	50	65	55	40
Bent ²	10	50	20	40	40
Crested Dogtail . .	10		15	3	20
Perennial Rye-grass .				2	

The constitution of these mixtures is also open to criticism. Why seedsmen continue to encour-

¹ By Fescue is meant forms of *Festuca rubra*, probably mostly Chewings' Fescue.

² The Bents include the commercial species of *Agrostis*, namely, Redtop-Creeping Bent, and Rhode Island Bent.

age the use of Crested Dogtail on American golf courses is still undetermined. Whatever its merits may be in Europe, this grass is practically useless in the United States, excepting on the Pacific Coast west of the Cascade Mountains. Most European grasses have become abundantly naturalized in the northern states, but Crested Dogtail is found only rarely, and, even when sown with care, few plants grow to maturity.

Perennial Rye-grass grows well but is quite unsuited for putting-greens, since it is entirely too coarse to be mixed with Creeping Bent and Red Fescue. Incidentally, the inclusion of these two species in putting-green mixtures intended for use in the United States is *prima facie* evidence that the basic principles of mixtures are not fully comprehended by all seedsmen.

Discarding Crested Dogtail and Perennial Rye-grass, what actually composes the mixtures are Chewings' Fescue and Creeping Bent. There can be no criticism of their use, since of all the commercial grasses they are beyond doubt the best two for putting-greens, and the only ones, with the exception of Rhode Island Bent, that should be planted for such purposes in the North.

It is in this connection that another objection is found in the ready-made mixtures. The seeds of both Chewings' Fescue and Creeping Bent are subject to adulteration with very similar seeds, and in mixtures the adulteration is more difficult to detect. With a knowledge of the facts concerning the various bents and fescues, and by buying each separately from a reliable seedsman, the chances of securing the desired varieties are greatly increased. Granting for the moment that mixtures are desirable for the putting-green, seed of the component species should be purchased separately for quality's sake, and since the question of exact proportions is of little importance, any one with a reasonable degree of intelligence can compound a mixture with the proper constituents that will be at least as satisfactory as those that are offered in the trade.

The whole question as to the use of mixtures requires discussion. Why are mixtures ever employed? Chiefly perhaps because of a long-standing practice in agriculture. Even nature herself seems to furnish an adequate reason through example. Mixed plant associations are the rule rather than the exception. The advocates of mixtures



PLATE VIII.—Upper. "Cut-in" seeder, a useful implement to plant seed in turf.

Lower. Sowing seed on a putting-green with a cut-in seeder.

for putting-greens, therefore, have reasoned largely from analogy and somewhat along the following lines. Species vary in their range of adaptation to soil and climate; consequently, it stands to reason that, using several or many together, the chances of securing good permanent turf are correspondingly increased. For ordinary lawns the mixture idea undoubtedly possesses merit, but on putting-greens there is reason for a different view. If there is such a thing as standardization of soil conditions, it is certainly to be found in the case of the modern putting-green. Variation in soil is reduced to the minimum, and conditions are made as uniform as possible, thereby doing away with the main prop of the mixture theory. As for climatic requirements and habit of growth, the valuable species have never been known to produce what may be called a supplemental effect in either respect when grown together. That is, one species does not make the turf at one period, and the other one subsequently. The critical period of the year of one species is essentially the critical period for most others. Thick turf can be secured as readily from the use of these species singly as in mixtures. Apart from the lack of any conclusive evidence in favor

of mixtures on putting-greens, there are some valid objections to them. Uniformity of texture is one of the first requirements of a putting-green turf, and while various factors influence this characteristic, it is to a considerable degree dependent on the nature of the species of which the turf is composed. Since Chewings' Fescue and Creeping Bent are appreciably different in texture, the practice of mixing the seed of these species for putting-greens would seem to be in violation of one of the fundamental principles of green-making. Chewings' Fescue and Creeping Bent do not produce a uniformly mixed turf, but after a few years a patched one composed of small and large areas of each growing separately. Such a condition is certainly not conducive to uniformity of texture.

Uniformity of color is likewise sacrificed through the use of mixtures, a matter which is of course only of æsthetic importance. If the chances of maintaining a thick permanent turf could be increased by mixed seeding, uniformity of texture might be sacrificed to some extent and uniformity of color entirely, but there is lack of evidence to show that mixed seedings are helpful in this respect.

From the standpoint of economy the arguments

are all opposed to seed mixtures. If there were an adequate basis for carefully compounded mixtures, golf clubs might be justified in paying the higher price at which mixtures are held, but since this adequate basis does not exist, it is economy to buy seed of each species separately. This is the case, not only because the club can save money by so doing, but also because it will be more likely to secure a better quality of seed.

There is no mystery about the commercial origin and characteristics of the seed of Creeping Bent and Chewings' Fescue, as well as the other seeds which sometimes have been substituted for these. No one seedsman has any advantage over the others in the purchasing of these seeds. Chewings' Fescue as it is exported from New Zealand contains, as a rule, but a small quantity of impurities. Creeping Bent has more impurities, but they are not of a serious nature. The only advantage that one seedsman can have over another, then, would be in the matter of recleaning, but Chewings' Fescue is notably clean and pure, while the cost of Creeping Bent is such that recleaning is seldom practiced, because of the necessarily large loss of seed.

It must be admitted that good putting-greens

composed of a mixture of Creeping Bent and Red Fescue are found on many golf courses. The best of these, however, are certainly no better than the best greens composed of either of these grasses alone. In short, there seems to be no argument why the use of these two grasses in mixture should be preferred to either one alone.

Where two grasses occur in sequence on a putting-green, one in summer and the other in winter, the use of both cannot properly be designated a mixture. Thus in the South the turf on putting-greens in summer may be Bermuda-grass and in winter Italian Rye-grass or some other winter grass. In some localities Annual Blue-grass makes a perfect turf on Creeping Bent putting-greens from late fall till early summer. This grass may not be particularly welcome, as it may injure the Creeping Bent, but on the other hand it does provide an excellent putting surface.

GRASSES FOR FAIRWAYS

Turf for fairways need not be nearly as fine in quality as putting-greens, but on many courses there is a growing tendency to use the finest turf grasses, namely, Creeping Bent and Red Fescue.

It is doubtful whether this is wise from the standpoint of economy, and it is certainly open to serious question whether these two grasses possess for fairway purposes more desirable qualities than the more easily grown, slightly coarser grasses such as Blue-grass and Redtop. On the other hand, there can be no objection other than these mentioned to using Creeping Bent or Red Fescue on fairways, providing they will thrive without excessive care.

Many golf courses have been constructed on land already in grass, and the fairways on such were usually part of this original turf. The common turf grasses on old pasture land in the North are Kentucky Blue-grass, Redtop, and White Clover, excepting in New England, where Rhode Island Bent is predominant. Of course there are always other grasses mixed with these, but they are rarely abundant enough to give character to the turf. In the South permanent grass land is mostly Bermuda-grass more or less intermixed with Japan Clover, except along the Gulf Coast and in Florida, where Carpet-grass tends to be predominant. In the Great Plains regions numerous short grasses, especially Buffalo-grass and several Mesquite grasses, make up the natural turf.

Generally speaking, the turf grasses above mentioned which tend to hold their own on the land are most easily utilized for fairways, and all of them provide a satisfactory turf. The improvement of this established turf is usually much less expensive and more satisfactory than to plow the land and to seed new grasses.

On land that is not already in grass or where the turf is so weedy as to be undesirable, the preparation of the land for seeding is necessary. This preparation should consist of good plowing and thorough harrowing so as to make a fine, firm seed-bed. An excellent implement to give the seed-bed a fine, even surface is the smoothing harrow. If possible, a heavy application of barnyard manure should be made before plowing. In the absence of barnyard manure, such organic fertilizers as bone-meal or cottonseed-meal are preferable to chemical fertilizers. Any of these are best applied after plowing but before harrowing.

If Blue-grass is to form the basis of the turf on the fairway, liming is also desirable, using preferably two tons of fine ground limestone to the acre. Bermuda-grass and White Clover are also helped by the use of lime, but other turf grasses are scarcely affected.

Crab-grass is sometimes very abundant on fairways in summer and makes a very satisfactory but rather coarse turf. The principal objection to it is the danger of the seeds being carried to the putting-greens, and the rather unsightly appearance of the turf after the first killing frost. No matter how thick the Crab-grass may be, the perennial grasses usually recover and begin growth again after the Crab-grass dies.

When the ground has been prepared for seeding, the sowing should in the North be in the fall, September being the best month. Heavy seeding is advisable. The seed should be broadcasted both ways across the land and then followed by a light roller.

The important turf grasses to sow on fairways are as follows :

Kentucky Blue-grass. — For use in the North generally. Seeding should be done in September, using 150 pounds of seed to the acre. Liming is beneficial.

Redtop. — Generally useful in the North. Seed in September, using 40 pounds of “re-cleaned” seed to the acre. Liming is not particularly beneficial.

Rhode Island Bent. — The common natural turf

grass in New England. Seed in early fall, using 40 pounds of seed to the acre. Liming is not beneficial.

Red Fescue. — Well adapted to New England and the northern tier of states. Seed in September, using 100 pounds of seed to the acre. Liming is not markedly beneficial.

Creeping Bent. — Use as recommended for Red-top, but the seed is expensive.

White Clover. — Useful in the North, especially on very poor soils. Sow in September, but only in mixture with a grass, using 5 to 10 pounds of seed to the acre.

Bermuda-grass. — The principal fairway grass of the South. It may be propagated by seed or by cut-up turf. Seed or plant preferably in early spring, but the turf method may be used any time during the growing season. Liming is beneficial.

Carpet-grass. — Useful along the Gulf Coast and in Florida. May be propagated by turf any time during the growing season. Seed is rarely procurable unless harvested especially, but if available, seed in early spring. Liming is not beneficial.

Japan Clover. — Useful in the South on very

thin or poor land. Seed in early spring with 1 to 2 bushels of seed to the acre. Liming is helpful.

Italian Rye-grass. — Valuable for sowing on Bermuda-grass turf in the fall, so as to make a greensward for winter and early spring. Use 120 pounds of seed to the acre.

For fairway purposes, mixtures of some of the above grasses are very satisfactory and under ordinary conditions give superior results to any single grass. The commonest of these mixtures is that of Kentucky Blue-grass and Redtop, using four times as much seed by weight of the former as of the latter. White Clover also mixes well with these two grasses, and if desired, the proportion of this seed mixture by weight should be about 16 pounds Blue-grass, 4 pounds Redtop, and 1 pound White Clover.

Creeping Bent or Rhode Island Bent, and Red Fescue, also mix fairly well, and where such fine grasses are used on fairways, the mixture is usually superior to either one alone. About 6 pounds of the fescue seed should be used to each pound of bent seed, to obtain an equal number of plants of each.

Yarrow may be sown if desired in the Blue-grass and Redtop mixture. Japan Clover does well in

Bermuda-grass. Italian Rye-grass makes the most satisfactory green winter turf to alternate with Bermuda-grass.

GRASSES FOR THE ROUGH

It is generally agreed among golfers that the penalty for a shot into the rough should be no more, and seldom less, than one stroke. As a rule the rough should be of such character that the player is forced to use a mashie or other club with considerable loft.

On most courses no attempt is made to seed grasses for the rough, those that come naturally being depended upon. In general the best type of grasses for the rough are those which form heavy, and rather tall, tufts. Grasses which make a dense continuous mass of stems make it troublesome to find the ball, and in some cases the growth is so dense that it is difficult to make a stroke even with a heavy niblick. This makes an unfair penalty to the player.

In the East and South several species of Broom Sedge (*Andropogon*) are very common native grasses. Broom Sedge is an almost ideal grass for the rough, as it grows all summer and does not

mature till late fall. The tufts are usually scattered a foot or two apart, so that it is not particularly difficult to find the ball, and there is nearly always a fair chance to make a moderate shot with the niblick or mashie. On most untilled land along the Atlantic Coast and in the South, Broom Sedge is sure sooner or later to make up much of the grass cover.

Among the cultivated grasses Orchard-grass and Tall Oat-grass are very satisfactory. Both will thrive well over a large part of the United States. They are especially advised where the natural grasses do not make a suitable rough.

Orchard-grass properly seeded fills the requirements well. It is a hardy perennial, suited to a great variety of soils, ranging from light sand to poor, stiff clay. In the character of its growth it resembles Broom Sedge very closely. On hilly slopes that wash badly, Orchard-grass is valuable for binding the soil and preventing erosion. Because of its wide range of adaptation, its suitability, character, and longevity, it is one of the best of our cultivated grasses for the rough.

Tall Meadow Oat-grass has much the same bunch-forming habit as Orchard-grass, but is taller and

slightly less coarse. In soil and climatic requirements, the two species are much the same, and a combination of them frequently gives better results than either alone. In fact, a mixture is usually to be preferred to a single species for the rough, and to the combination of Orchard-grass and Tall Meadow Oat-grass, Timothy and Meadow Fescue may well be added in small quantities to offset the bunching tendencies of the first two species.

On very sandy land Sheep's Fescue and Hard Fescue are probably the best grasses for the rough. Neither of these grow tall, but they make very tough tussocks of grass that hold the soil firmly, and the cuppy lies between these tussocks seldom permit a player to secure a full shot.

For growing on sandy mounds about bunkers, Sea Lyme-grass (*Elymus sabulosus*) is very showy and satisfactory. This grass is coarse and with attractive bluish leaves. It spreads and is propagated by creeping rootstocks which can usually be obtained from nurserymen.

Marram-grass (*Ammophila arundinacea*), so commonly planted along sandy coasts to hold the drifting sands, is also used on sandy golf courses for the same purpose.

CHAPTER IX

THE MAKING OF THE TURF

AFTER the improvement of the soil with regard to its texture, humus content, and drainage, there still remains much to be done before good turf is actually secured. Good grass is found on every hand, but really good turf is far from common. It is proposed here to discuss methods of sowing the seed, improvement of poor turf, sodding, and the seeds of the principal grasses that are used in turf-making.

SEEDING NEW GREENS

The importance of sowing grass seed properly for the production of fine turf can scarcely be over-estimated, since upon it the quality of the resultant turf is to a very large degree dependent. With the choice of seed a settled question, the chief factors involved in seeding are the time of sowing, preparation of seed-bed, rate of sowing — by which is meant the quantity of seed used on a given area,

distribution of the seed, and the covering of the seed. These apply alike to fairway and putting-greens, even though their relative importance may be somewhat different for the two portions of the course. For a large part of this country where golf is played, the time of seeding is an extremely important consideration. With the exception of parts of New York and the New England states, and the parts of the South where Bermuda-grass is used, seeding in the late summer or early autumn is almost necessary for success. The optimum date varies from early August to early October, depending on the locality. At this time of the year the severe heat of summer is past, and with it the aggressiveness of summer annual weeds, both of which are a serious menace to young seedlings. Also at this time of the year the moisture conditions are usually very favorable, and there is enough heat to produce a sufficient growth to enable the grass to survive the winter in good condition.

Grasses, when sown in fall or at the beginning of a period of cool weather, show a conspicuous tendency to form stools, whereas if sown during warm weather this tendency is inhibited, each plant growing tall and slender. Consequently, if sowing



PLATE IX. — A general view of the operations in lifting and laying turf.

is done in late spring or early summer much larger quantities of seed are necessary to make a dense sward.

In parts of New York and the New England states, spring seeding is preferable to late autumn seeding largely because of the effect of the severe winter climate on the young grass. Fortunately the spring season in the North is usually very favorable for seeding, since no periods of severely hot weather occur until July.

Because of its quick response to frost, it is almost necessary in the South, where Bermuda-grass is used to sow it in the spring. Since this grass is a very aggressive species and delights in warm weather, it is not seriously handicapped by heat or weeds.

A thorough preparation of the seed-bed contributes largely to the success of the turf, and only by thorough preparation is it possible to obtain a uniform stand of grass, regardless of the quantity of seed sown or the evenness with which it is distributed. Good preparation of the seed-bed consists of the thorough stirring of the soil, and a sufficient packing of the sub-surface. The surface to a depth of two to three inches should be well fined,

but not compacted. When autumn seeding is to be practiced, early summer plowing is advised. The summer rains falling upon the loosened soil go far towards settling it, and by frequent disking and harrowing a properly settled seed-bed results. Disking and harrowing also destroy large numbers of weed seedlings. An excellent implement for fining the surface, which should be used just prior

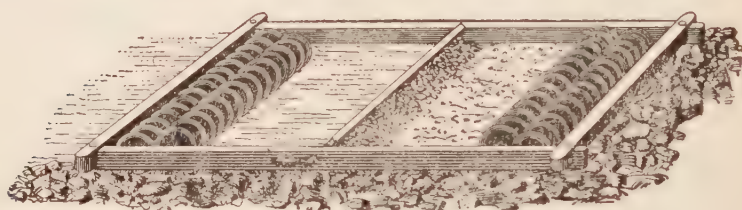


FIG. 27. — Meeker harrow, a very useful implement for fining the soil surface just before seeding.

to seeding, is a harrow consisting of four series of straight disks set in a frame in a position similar to that in which the teeth of a spike-tooth harrow are set (Fig. 27). This implement not only pulverizes the surface, but also levels it effectively. On putting-greens where an undulated surface is to be produced, this harrow can be used to advantage in preliminary preparations, and to a limited extent for the final working of the soil.

Thorough preparation is essential alike for the

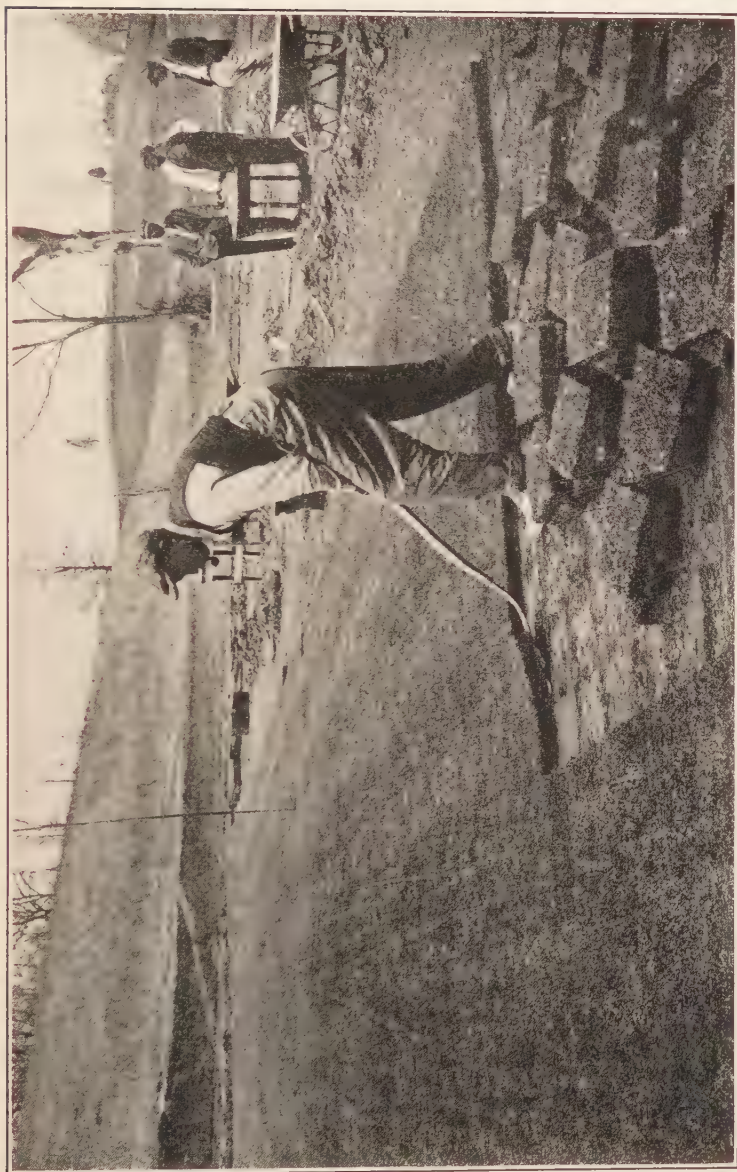


PLATE X. — Lifting turves from an old green after the sod has been cut into 10-inch squares.

fairway and the putting-green, and in all operations just before seeding where horses are employed, they should be provided with special shoes in order that deep foot-tracks may be avoided. If lime or humus materials are to be incorporated with the soil during the course of preparation of the seed-bed, they should be applied after plowing and just before the first disking or harrowing. Barnyard manure, unless finely comminuted, should be applied before plowing in order that it may be turned under completely. Commercial fertilizer should be applied just before the last fining cultivation preceding the sowing of the seed. This insures its thorough incorporation with the surface soil.

In the table on the following page is shown the average number of seeds to the pound, and the average percentage of germination of the various kinds of turf plants.

There is no very definite relation between the number of seeds to the pound and the rate at which each species should be sown, since the latter depends on various factors other than the number of seeds involved. The figures of the table, however, disclose clearly why it is not necessary to sow as many pounds of seed of the bent grasses to a given

area as of the fescues. Too light seeding is practiced more commonly than too heavy seeding. Injury very seldom results from sowing seed thickly, while thin seeding is very frequently the cause of poor turf. A uniform and satisfactory stand of grass can rarely be obtained by a light rate of seeding, and for this reason it is usually poor practice to economize on seed.

TABLE SHOWING NUMBER OF SEEDS IN ONE POUND OF VARIOUS
TURF PLANTS

NAME OF PLANT	AVERAGE NUMBER OF SEEDS IN A POUND	AVERAGE PERCENTAGE OF GERMINATION OF HIGH- GRADE SEED
Creeping Bent	6,000,000	85
Rhode Island Bent . . .	6,000,000	85
Redtop	6,000,000	85
Kentucky Blue-grass . .	2,400,000	70
Bermuda-grass	1,800,000	80
Red Fescue	500,000	70
Sheep's Fescue	700,000	70
Fine-leaved Fescue . . .	1,200,000	70
Various-leaved Fescue . .	400,000	70
Italian Rye-grass . . .	270,000	85
Perennial Rye-grass . .	300,000	85
Yarrow	3,500,000	80
White Clover	750,000	90
Japan Clover	370,000	85

Practices and recommendations vary greatly with regard to the rate of seeding for both fairway and



PLATE XI. — Trimming curves to equal thickness. The trimming box is $1\frac{1}{2}$ inches deep and the trimming is done with an old scythe blade.

putting-greens. The consensus of opinion, however, seems to indicate that 100 to 150 pounds of seed — depending somewhat on the mixture — is sufficient for an acre of the fairway. For the putting-greens as much as twenty pounds to 1000 square feet have been recommended, but five pounds of the bent grasses, or seven pounds of Red Fescue, seem to be sufficient for this area. This is true where the ordinary methods of seeding are employed. If the seed is mixed with compost, peat, or some other germinating mixture, and spread evenly over the surface of the soil after the Taylor method, a much smaller quantity is required. This seems to indicate that the necessity for thick seeding is very largely due to poor preparation of the seed-bed and uneven distribution of the seed. Very heavy seeding frequently results in such a poor growth of roots in the young grass plants that a durable turf is very slow in developing.

Broadcasting is essential to the even distribution of seed. Ridges in the turf are certain to result if the drill is used. An experienced workman can scatter seed very evenly by hand, but a small hand-operated seeder is usually to be recommended for seeding both fairway and putting-greens. If one-

half of the seed is sown in the direction of one diameter of the area, and one-half at right angles to it, a fairly even distribution at least should result. One of the advantages of heavy seeding lies in the fact that it increases the possibility of even distribution, or at least modifies the effect of uneven distribution, which has very much to do with the success of the turf.

It is not an easy task to cover seed properly. On large areas, especially on the fairway, the weeder



FIG. 28. — Weeder, a useful implement for harrowing the land after the seed is sown.

(Fig. 28) can be used and is the best implement available. For portions of the putting-greens the hand rake is the only tool that can be employed. On account of its continuous sweep the weeder is more satisfactory than the rake, since the short strokes necessary in connection with the use of the latter



PLATE XII. — Laying turves on the well-prepared foundation of the new putting-green.

have a tendency to leave the seed in irregular rows. Shallow, even covering, followed by light rolling, provides good conditions for germination. The roller, however, should not be used when the soil is wet.

IMPROVING POOR TURF

On golf courses it is often more convenient and not infrequently more satisfactory to improve poor turf than to prepare and seed the land for new turf. This is particularly true of fairways, the plowing up of which prevents play upon them for a period. Even where the turf is originally very poor, much can be done to improve its character without interference with the game. On steep slopes plowing should rarely, if ever, be resorted to, as the danger of injury by gullying and washing may far outweigh any advantage that may reasonably be expected from the plowing.

To improve poor turf the most important methods are top-dressing, seeding, and gentle scari-fying.

Various top-dressing materials are helpful, dependent upon the conditions. Well-rotted barn-yard manure is always beneficial, and one or two applications often make wonderful improvement.

Good loam soil is also excellent, and especially needed where the surface soil is very thin or stony. Liming is advisable where the grass is largely or mainly Blue-grass, but otherwise it is of doubtful

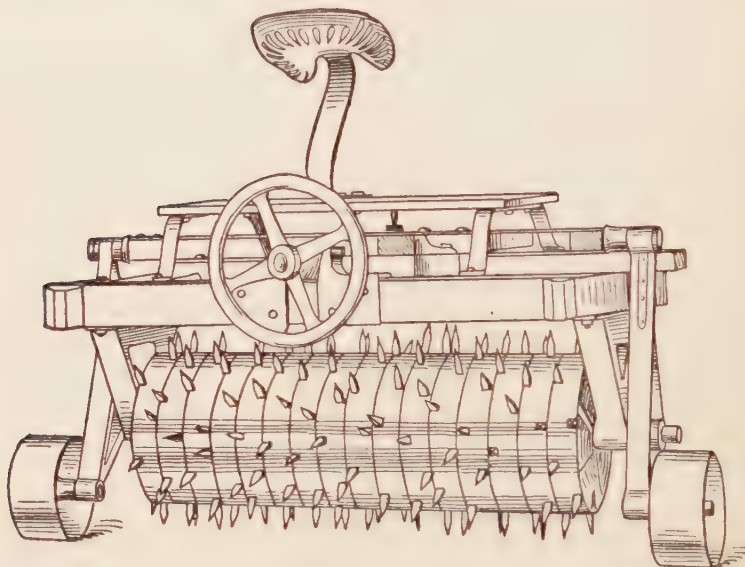


FIG. 29. — Toothed roller, useful for scarifying when applying seed or fertilizer in fall.

benefit. If fertilizers other than barnyard manure are used, they should preferably be of an organic nature such as humus fertilizers, cottonseed-meal or bone-meal, as the effect of these is generally slower and much longer continued.

Sowing good turf grass seeds in poor turf each



PLATE XIII. — A method of cutting turf on fairways. The implement (see Figure 31) cuts the turf into strips 10 inches wide and about 2 inches thick.

year will gradually change its character to that desired. In seeding old turf it is important to get the seeds into the ground. This may be done by the use of a cut-in seeder (Plate VIII); by the use

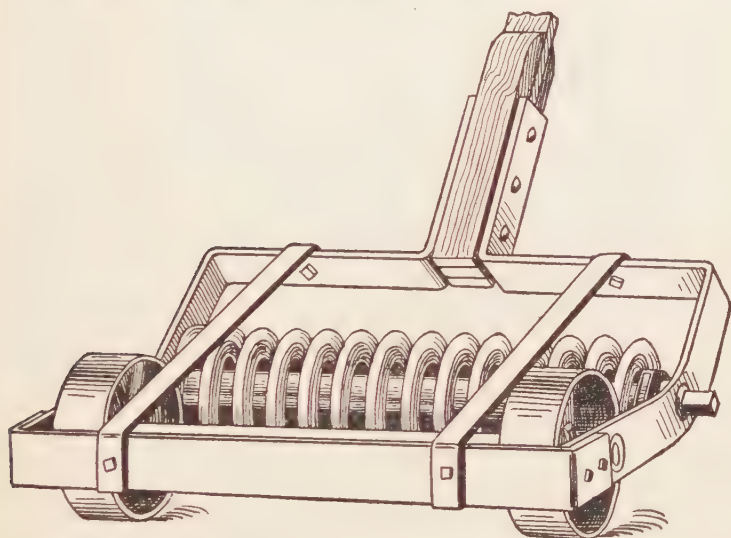


FIG. 30. — A good type of machine for scarifying turf when seed is sown or fertilizer applied in fall.

of some scarifying implement, such as a toothed roller (Fig. 29) or the cutting harrow shown in Fig. 30; or by seeding and then top-dressing with good soil. On stiff clayey soil top-dressing with sand and liming are both to be recommended. The seeding is best done in the fall at a time when moisture conditions are favorable.

SODDING OR TURFING

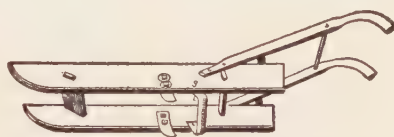
There frequently arise conditions in the development of a golf course in which it is desirable to lay the sod or turf instead of seeding, notwithstanding the greater expense. On steep banks sodding is always more satisfactory than seeding, especially if the soil be poor. It happens not rarely that a turf capable of being played upon is desired in the shortest possible time. For such cases sodding possesses a great advantage over seeding, as the turf may be played upon a few days after laying.

New putting-greens are sometimes sodded completely as soon as the surface is prepared. For this purpose only first-class turf should be used, and ordinarily this has to be grown especially, excepting where the turf is transferred from an old green.

In the mechanical operations of turfing, two things are of particular importance, namely, to have the turf of even thickness, and to have the cut edges vertical. There are special turf-cutting machines to be had which will do this work more accurately than it can be performed by hand. Excellent results may, however, be secured by using only a

large knife and a board ten or twelve inches in width to use as a guide so that the pieces of turf are uniform in width. It is a good plan to cut the turf both ways before lifting so that all the pieces are either ten or twelve inches square. In place of the knife a special rolling colter may be used advantageously.

A double colter with the blades ten or twelve inches apart



will further reduce the labor of cutting. For

FIG. 31.—Implement used for cutting sod, also shown in operation in Plate XIII.

rapidly lifting turf that need not be cut accurately an ordinary turf cutter of the sled type (Fig. 31) may be used.

In laying turf the pieces should be put together only fairly close. Due care should be taken to trim to an equal thickness. The trimming may be accomplished with a large knife, first inverting each piece of turf in a frame of the desired thickness, one and one-half inches being about correct. If the turf be laid with care, there is usually left ample space to permit expansion where the laid turf is rolled. If, however, some pieces be thicker than others, a roller heavier than is desirable must

be used, and even this may not overcome the difficulty as it may cause the turf to buckle up at the joints when the pressure is released. Care in laying the turf is the most satisfactory way to avoid trouble.

When the sod is to be transferred from an old green to a new one, the various operations to be followed may be thus detailed:

1. Cut the turf to be lifted into ten-inch squares, using a board as a guide.
2. Lift the turves with a turf lifter.
3. Trim the turves in a trimming box so that each is one and one-half inches thick.
4. Lay the turves on the prepared ground on the new green, using boards to prevent the new-laid turves from being injured by the wheelbarrow or by trampling.
5. Top-dress with sand or sandy loam and sweep to fill all interstices.
6. Water to get the turves thoroughly saturated and to settle any loose soil in the interstices.
7. Twenty-four hours later, or after the turf is well drained, roll with a roller of moderate weight.

The details of the processes above described are nearly all illustrated in Plates IX to XV inclusive.



PLATE XIV. — Chopping fairway turf into approximate squares after it has been cut into strips.

The need for patching with sod is almost continuous on putting-greens. Poor pieces of turf occasioned by weeds or otherwise are best remedied by bodily removal and replacing with new turf. In patching two things are important : (1) that the new piece of turf be of the same outline as that removed, and (2) that it be rather thick. Circular turf-cutters of different sizes insure patches that fit exactly, but it is still better if the patch be slightly smaller than the hole, as then pressure with the foot will make it fit snugly. Patching is often very unsightly because the new pieces turn yellowish or brownish. This may be avoided by having the patches thick and transplanted immediately so that the grass secures practically no setback. Turf patching that is thin or which has been removed too long before replanting is practically sure to turn yellow. If the patch be taken from softer ground, it should be slightly thicker than the piece removed.

Inasmuch as patching is so often employed on putting-greens, every golf course should have a special piece of land on which to grow this turf. Such a sod patch will require practically the same treatment as a putting-green so that the turf will

be of essentially the same quality. Still better, perhaps, is to have the fairways sown to fine grasses so that patching may be secured from the fair green.

THE SEEDS OF THE PRINCIPAL TURF GRASSES

By dealing with a reliable seedsman one can be sure that he is securing the seeds desired, unless, as happens in some cases, the seedsman himself is deceived. For fine turf the principal seeds used are those of the bents, the fescues, and the blue-grasses. The seeds of these three groups are so different that they are easily recognized, but it is less simple to distinguish from one another the seeds of the three different bents, or the five fescues, or the two blue-grasses.

The bents, which include Creeping Bent, Rhode Island Bent, and Redtop have very small seeds, one pound containing 4,000,000 to 8,000,000. The seeds of Creeping Bent and Rhode Island Bent are quite indistinguishable except by the weed seeds present. The former comes from Germany, the latter from New England, and so it happens the weed seeds incidentally present betray to an expert the source of the seed.



PLATE XV. — Distributing curves for laying on a fairway. The operations are rapid, as little care is necessary.

Redtop seed (Figs. 32, 33) in bulk may be distinguished from the other two bents by its silvery purplish color, instead of a yellowish straw color. Individual seeds of Redtop are also distinguishable under a microscope to an expert. As Redtop is much cheaper than the other bents, it has been employed as a substitute or adulterant. Such practice will not be resorted to by a reliable seedsman.

The quality of seed in all three of the bent grasses varies greatly, due to variation of the season and the degree of recleaning to which



FIG. 32.—Seeds of Redtop representing the “fancy” grade of the trade. *a*, different views of seeds having the white, papery, inner chaff; *b*, two views of a grain, or kernel, with the inner chaff removed; *c*, the same, nearly natural size.

they have been submitted. Redtop as harvested weighs twelve to sixteen pounds a bushel in the hull, but with the glumes removed the “fancy” or “choice” recleaned seed as it commonly appears in the trade weighs from thirty to forty pounds a bushel. Practically the same variation in weight occurs in Creeping Bent, and for the same reason. As a matter

of fact, however, Creeping Bent is seldom recleaned, owing to its high price and to unavoidable loss which attends recleaning. The wholesale price of unhulled Redtop seed ranges ordinarily from 7 to



FIG. 33. — Chaff of Redtop seed. *a*, whole spikelets usually devoid of seed in "chaffy" grades; *b*, separated scales of the same; *a* and *b* represent the outer chaff of the seed. (Enlarged.)

15 cents a pound, while the same grade of Creeping Bent sells for 25 to 30 cents a pound. The wholesale price of recleaned Redtop varies ordinarily from 19 to 26 cents a pound.

With improved recleaning machines,

numerous grades of seeds may be separated from any bulk lot of Creeping Bent or similar seeds (Plate XVI). As the cost of the seed is one of the smallest items in securing a fine putting-green, it is good policy for golf clubs to demand the best grade of seed that can be secured by recleaning. There is no valid reason why seedsmen should not supply seed equal in quality to the best grade shown. Such recleaned seed free from weeds would more than repay any reasonable increase of

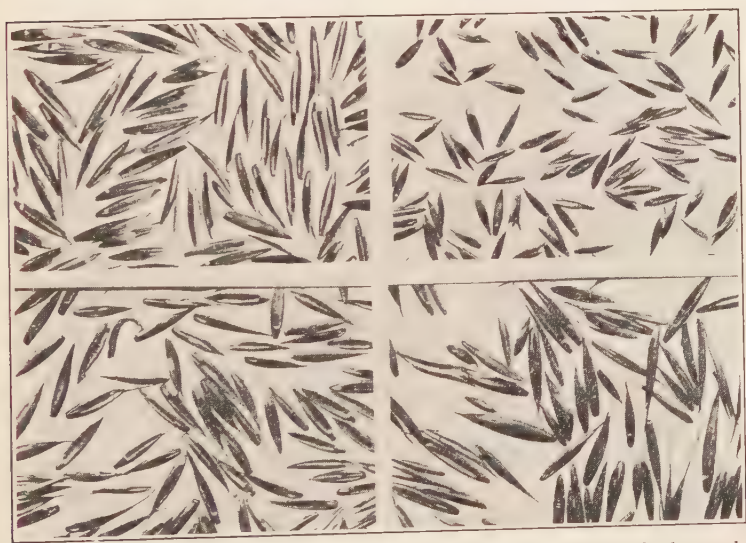
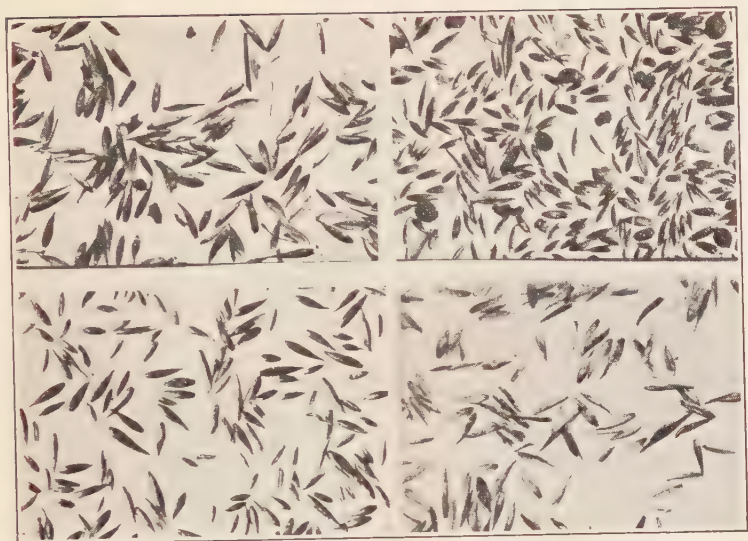


PLATE XVI.—Upper. Creeping bent seed, enlarged. The original sample, upper right, contains many weed seeds. By recleaning the other three grades were obtained, that in the lower left corner being pure.

Lower. Seeds of four kinds of fescues used for turf purposes: upper right, fine-leaved fescue; upper left, various-leaved fescue; lower right, sheep's fescue; lower left, red fescue.

price, as ordinary Creeping Bent seed usually contains several very troublesome weeds, among them mouse-ear chickweed, sorrel, plantain, and veronica.

Fescue seeds of the five kinds used for turf purposes are very much alike (Plate XVI). Indeed, in the seed Sheep's Fescue is almost indistinguishable

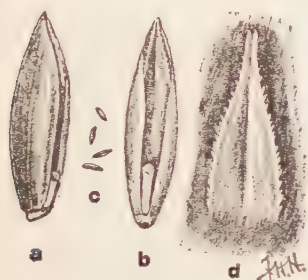


FIG. 34. — Kentucky Blue-grass seeds. *c*, natural size, the others enlarged; *a*, side view; *b*, front view; *d*, the palet, showing character of margin.

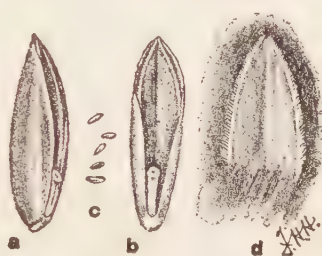


FIG. 35. — Canada Blue-grass seeds. *a*, side view; *b*, front view; *d*, palet, showing the character of the margin; *c*, seeds natural size, the other figures enlarged.

from Hard Fescue; and Red Fescue and Various-leaved Fescue are very closely similar. On the other hand, Fine-leaved Fescue is easily recognized by its smaller seeds and the absence of awns. Red Fescue is the most important of this group of grasses and the most common seed is that from New Zealand known as Chewings' Fescue. This as obtained from trustworthy seedsmen is usually of high purity, but it may contain a few undesirable weed seeds.

Seeds of the two Blue-grasses (Figs. 34, 35, 36), Kentucky and Canada, are larger than the fescue



FIG. 36. — Seeds of Kentucky Blue-grass *a*, and Canada Blue-grass *b*, all enlarged.

seeds, and differ from all except Fine-leaved Fescue in having no awns. The two kinds of Blue-grass seeds are much alike, but may be distinguished as indicated in the illustrations.

Formerly Kentucky Blue-grass seed was much adulterated with the cheaper seed of Canada Blue-grass, but this is never practiced by good seedsmen. There may be various incidental weed seeds in Kentucky Blue-grass, but as this is used primarily on fairways, the few weeds can do no particular harm. Canada



FIG. 37. — Seeds of Italian Rye-grass, natural size and enlarged. Note the awn or bristle-like tip.



FIG. 38. — Seeds of Perennial Rye-grass, natural size and enlarged. Note the absence of awn at tip.

Blue-grass is rarely used on golf courses, but for thin or hard soil makes a good tough turf for fairways.



FIG. 39. — Seeds of Bermuda-grass, different views, the figures at *f* being natural size.

Other seeds of turf grasses often

used include Italian Rye-grass (Fig. 37), Perennial Rye-grass (Fig. 38), Bermuda-grass (Fig. 39), and Crested Dogstail (Fig. 40).

In purchasing seeds it is well to buy only from dealers of known reliability. One should never



FIG. 40. — Seeds of Crested Dogstail, natural size and enlarged. They are bright yellow in color.

purchase seed mixtures but make one's own mixtures from pure seed. When large purchases of seed are to be made, it is well to secure samples and prices first from different seedsmen, and have these passed upon by an expert. A little experi-

ence will convince any one that competition in the seed business is keen and that with rare exceptions seedsmen are honest.

CHAPTER X

SUBSEQUENT CARE

THE land once well prepared, the seed well chosen, and the seeding properly performed, there remains the continuing care and good management if the golf turf is to be satisfactory. The maintenance cost of any enterprise is known to be great, and oversight must never be lessened; this is as true in keeping up a good turf as in other undertakings.

MAINTENANCE OF PUTTING-GREENS

In most parts of this country the maintenance of a putting-green in first-class condition represents the acme of accomplishment in grass culture. This is largely true because the climate, with the exception of rather limited areas in the United States, is not favorable for the development of a high quality of fine turf, so that good putting-greens can be maintained only by constant, intelligent, and in most cases costly, attention. Even in the Middle Atlantic states where the finer turf grasses are used, and where

both soil and climate are for the most part unfavorable to their best growth, some excellent putting-greens are maintained throughout the entire year. From this it would appear possible with the data already available to prescribe a course of treatment that could be depended on to give uniform and thoroughly satisfactory results, but there are so many uncontrollable factors that no one, regardless of his training and experience, is capable of outlining a treatment that will prove infallible. Knowledge of the subject of fine turf-culture is, after all, a very vague, uncertain kind of knowledge, and it is no confession of ignorance to admit that recommendations for the care of putting-greens must necessarily be of the nature of general suggestions rather than hard and fast rules strictly to be followed.

To obtain a good putting-green is one thing, and to maintain it is another. Many greens have been very promising at the beginning and have continued in a satisfactory condition for a season or even longer only to break down at a critical time, and refuse to recover under the best known treatments. However, there is little doubt that many failures could have been obviated by the application of certain fairly well-defined principles of turf-culture.

Fertilizing.

There is now, and probably always will be, a decided difference of opinion with regard to the use of fertilizers on putting-greens. This difference of opinion is not confined to the kinds of fertilizers, and the time and rate of application, but extends to the broader subject of whether they should be used at all. After examining the evidence carefully, there can be little doubt as to the benefit of fertilizers, but with regard to the kind, time, and rate of application there is some room for a legitimate difference of opinion.

The one fact that is brought out clearly as the result of experiments with fertilizers is that top-dressings have a stimulating effect on the growth of grass. Turf that has been developed on soil that is naturally fertile needs comparatively little fertilizing, but on the average putting-green soil fertilizers are certainly helpful. If the grass starts slowly in the spring, an application of ten pounds of nitrate of soda to a thousand square feet carefully applied is decidedly beneficial. As a fertilizer to be used regularly, nitrate of soda is preferable to sulfate of ammonia, and in the opinion of many green experts is the most satisfactory fertilizer for putting-greens.

Two, or possibly three, light applications of nitrate of soda in the spring at intervals of a month apart are preferable to a single heavy application, but the advisability of using this fertilizer in the summer months is yet to be demonstrated

A more lasting fertilizer than nitrate of soda in many cases seems desirable, and for this reason bone-meal is very commonly used, regardless of the fact that it appears to encourage the growth of White Clover. A study of the practices followed by the various golf clubs throughout this country with regard to the use of fertilizers reveals a very extensive use of bone-meal, which is surprising in view of the prejudices commonly held against it. Very early spring applications of bone-meal at the rate of twenty pounds to 1000 square feet almost invariably improve the growth of grass, and the effect lasts throughout the season. Cottonseed-meal can be used instead of bone-meal if desired, but applications of it sometimes produce injurious results, and therefore caution is urged in connection with its use. Cottonseed-meal contains approximately 7 per cent of nitrogen, 1.5 per cent of phosphoric acid, and 2 per cent of potash. An application of 25 pounds to 1000 square feet is usually recommended for putting-greens.

It appears from the data at hand that a rational application of a fertilizer high in available nitrogen and relatively low in phosphoric acid and potash is more beneficial than an application of fertilizers containing nitrogen alone. A moderate dressing of a quick-acting, nitrogenous fertilizer in the early fall has proved very helpful. However, it is not well to fertilize putting-greens heavily late in the fall, as it has a tendency to induce too active growth before winter begins. Fertilizing during the hot summer months has not generally given good results, and cannot be recommended.

It is a very common opinion that fine turf needs some protective covering during the winter, and, therefore, well-rotted manure and other humous materials are very generally used for this purpose. The need for a protective covering for grass in most parts of this country has been very greatly over-estimated, since thoroughly drained greens composed of the bents and fescues when left uncovered are very rarely injured by winter conditions. Applications of humous materials, however, serve a very useful purpose in supplying organic matter to the soil, and such applications can be made to advantage in the winter or early spring. However,

no manure or other organic material should be applied that is not thoroughly comminuted; otherwise, the grass under the large pieces is likely to be killed. The material that is applied in the winter should be so fine that little or nothing will remain to be raked off in the spring. Spiked rollers (Fig. 29) are now manufactured for perforating the turf and thereby enabling the humus to become somewhat mixed with the surface soil. A treatment with such an implement is helpful just before and after the application of the humous dressing. Top-dressings of humus in the spring frequently produce immediate results. This is probably very largely due to the fact that they raise the temperature of the surface soil. Even inert peat moss has been observed to cause the grass to start quickly in the spring. No matter when applied, humous dressings should be worked into the turf with a coarse brush or broom.

Apparently the only legitimate objection that can be raised to the use of humous dressings on turf is that they have a tendency to encourage infestations of the June beetle. These insects live on the humus in the soil, and are more common in areas that have been treated with manure or similar materials than elsewhere.

Sanding.

Putting-greens on heavy clay soils should receive dressings of sand at least once a year, and preferably oftener. Sand greatly benefits the character of the soil by improving its drainage and water-holding capacity, and producing other beneficial effects. In the improvement of the texture of clay soils, sand should be used liberally, as the sand produces a permanent change, while those induced by organic matter are at best of a temporary nature. Several applications of sand in the late autumn or winter aggregating in all the equivalent of a surface layer one-fourth of an inch in depth protects the grass to some extent, and reduces the effects of heaving. Sand materially aids in increasing the thickness of turf on clay soils. Fine sand, or sand containing a rather high percentage of silt, is not desirable, as it is inclined to form a crust, and because of its fine texture it does not appreciably improve the soil. Even heavy applications of coarse sand on putting-greens are soon taken up by the soil so that they do not interfere seriously with play.

Rolling.

Rolling is a treatment that should be employed in moderation, especially on putting-greens. The popu-

lar belief that rolling appreciably promotes the growth of grass has been largely responsible for the liberal use of the roller. The chief function of the roller is to smooth out irregularities in the turf due to alternate freezing and thawing in the spring, and to other causes. Heavy rolling should never be practiced on stiff clay soils, especially where the turf is thin. On sandy soils it does very little damage. Light rolling in the spring and occasionally throughout the season is helpful in maintaining a smooth turf. On the putting-greens a light, wooden roller used when the ground is wet, either by rain or dew, can do no damage. Water-loaded rollers have been found to be quite satisfactory in many cases, since their weight can easily be adjusted to suit the conditions of the soil and turf.

Mowing.

Very early clipping of putting-greens is to be avoided, especially when the turf is not very dense, since the roots of all perennial grasses are annual in duration and must develop in the spring before vigorous growth can take place. Grasses that have a reserve of food material in bulbs or rootstocks produce roots from this reserve, but in the ordinary turf grasses the quantity of stored material is very

small. Consequently, the early and vigorous growth of the roots depends on the food supply liberated in the leaves. If these are clipped early, the growth of the roots is inhibited, and the growth of the grass consequently weakened. Clipping does not force root development. It does, however, increase the stooling of the grass plant, but it does this much more advantageously after a good root system has been formed. Close clipping to the point of crowning should be avoided at all times.

Watering.

The artificial watering of putting-greens during the summer is necessary in most parts of this country. The kind of irrigation is of comparatively little importance so long as a sufficient amount of water is supplied. Erroneous estimates frequently are made as to the quantity of water applied during an ordinary irrigation, and an insufficient allowance is made for evaporation. At the time when watering is necessary, the humidity is relatively low, and more water is needed than would be the case under normal conditions of rainfall. Water should be applied freely at each application, and in such a manner that the ground will absorb it thoroughly. To insure good absorption a light preliminary sprinkling

is helpful. Heavy watering frequently results in much run-off, so that the greens are only slightly benefited, if helped at all. Greens should be thoroughly soaked when irrigation is needed. Light sprinkling wets only the top of the sod, thereby encouraging the formation of surface roots, and in most cases it is more harmful than beneficial. When the weather is hot and the sun shining brightly, watering should be done in the afternoon or evening rather than in the forenoon.

Weeding.

Probably the most expensive and troublesome feature of putting-green maintenance is the eradication of weeds. If left to grow unchecked, weeds will ruin the best greens, even if they have been established under the most favorable conditions. In Chapter XI the subject of weeds is discussed in some detail, but in connection with the maintenance of putting-greens there are a few points to which attention may well be called. The first step in the campaign against weeds is to secure a seed-bed and grass seed that is as nearly weed-seed free as possible. The degree to which this is accomplished has much to do with the future weed problem. The next important step is to commence weeding operations

early in the life of the green and early in the season. If weeds are allowed to make a good start, the damage which they do is often well-nigh irreparable. Spreading perennial weeds should be removed before they have made a mat of any considerable size, and Crab-grass, the worst summer annual weed with which the greens have to contend, should be eradicated as soon as the plants are large enough to pluck. The third step in weed control involves precautionary measures. Weeds, especially Crab-grass, growing near the greens should be prevented, so far as possible, from producing seeds, and the greens should be so constructed that weed seeds will not be carried on to them by flood water. Discretion should be used in the choice and application of fertilizers. Top-dressings containing vital weed seeds should be avoided, and likewise fertilizers which unduly encourage the growth of clover and other undesirable plants.

Reseeding and patching.

Putting-greens are seldom so good that they do not require repairing at some time during the year. The thickening of the stand of grass, or the filling in of small bare areas, resulting from the removal of weeds or other causes, is frequently necessary.

Reseeding in the spring is commonly practiced with a view to remedying poor turf. In very few sections of this country has the reseeded of putting-greens in the spring proved successful. If bare spots in the greens are a foot or more in diameter, a dressing of compost, or similar material with which grass seed is mixed, when applied in the spring, may result in improvement, but areas of this size should ordinarily be repaired by means of sod. Patching with good sod, if properly done, can be accomplished at almost any time during the growing season when the needs require, and is the best means of improving areas of considerable size. It frequently happens that the turf is thin or poor over a large part of the green, and in this case reseeded is about the only feasible method of improvement. Of the many methods that have been tried, reseeded in the early autumn with a seeder that cuts the seed into the turf has proved the most satisfactory (Plate VIII). For best results two applications should be made, one at right angles to the other, to bring about a more even distribution of the seed. A light dressing of fine compost, or humus, may well follow this treatment. If a "cut-in" seeder is not available, the seed may be mixed with the humous material and

spread over the area to be improved. On account of the difficulty which the young grass plants have in successfully competing with the older plants, the percentage of successes in reseeding is usually not high.

Controlling animal pests.

Suggestions for the extermination of animal pests will be found in detail in Chapter XII, but it is well to emphasize the fact that treatment should begin as soon as the work of the pest is in evidence. Moles may, with skill, be trapped promptly, and worms, ants, beetles, and crawfish can be poisoned successfully or otherwise destroyed. The methods, while tedious in certain cases, are nevertheless simple and usually so effective that there is rarely a good excuse for allowing serious damage to result from these pests.

SEASONAL WORK ON GOLF COURSES

Much of the work of maintaining good turf on a golf course must be done promptly as the need for it develops. This applies to such operations as mowing, watering, and fertilizing. There are, however, some things that are best done at a particular season, and it often happens that this is

not recognized until the most favorable time has passed. A few suggestions regarding operations that are best performed at a particular time of the year are therefore worthy of emphasis. These are outlined by seasons.

Fall.

Sowing grass seeds whether on newly prepared land or on old greens is nearly always best done in the fall, preferably September. This need is often neglected because it is not till spring that the greens usually disclose their imperfections. It is good insurance to seed putting-greens every fall.

In the northern tier of states, spring seeding of grass seeds is usually satisfactory, but even there fall seeding is preferable.

In the South, Bermuda-grass may be seeded or planted during the warm season, at any time from spring till midsummer. Italian Rye or other grasses for winter greens should be planted in October.

Winter.

Top-dressing of turf is best done in early winter or northward in late fall. This applies to the use of sand as well as of manure or other humous material.

Spring.

Weeding of putting-greens, especially of Crab-grass and other summer weeds, should begin just as soon as the weeds are large enough to pluck.

Fine grass seed may be sown in spring in the northern tier of states ; Bermuda-grass in the South should be sown in the spring. In most states spring seeding is rarely worth while.

Summer.

Mow weedy plants in the rough to prevent their seeding. This is especially important where Crab-grass is troublesome. By mowing the rough from August until frost comes, the trouble from Crab-grass may be greatly reduced.

CHAPTER XI

WEEDS AND THEIR CONTROL

WEEDS on golf courses become a serious problem only on the putting-greens. For practical purposes they may be considered in two classes, the perennials that live year after year, and the annuals.

The perennials include various plants of creeping habit that thrive under close turf conditions. Among these are white clover, yarrow, mouse-ear chickweed, ground ivy, pearlwort, sheep sorrel, thyme-leaved speedwell, carpenter-weed, creeping thyme, and selaginella. Other species of perennial weeds have stout taproots, such as dandelion, ox-eye daisy, plantain, and buckhorn.

Annual weeds may also be considered in two classes, namely, winter or spring weeds, and summer weeds. The former include such plants as shepherd's-purse, smooth chickweed, and whitlow-grass. The most serious summer annuals are goose-grass, pigeon-grass, and, worst of all, crab-grass.

Under certain circumstances mosses may become troublesome.

Creeping rooted perennials are satisfactorily destroyed only by cutting out the whole piece of sod and replacing with good sod. Some of the creeping weeds such as white clover, yarrow, pearlwort, creeping thyme, and others make a very fair putting surface. Such weeds are objectionable both on account of the patchy appearance they give the greens and the unevenness of the turf which they produce. It is useless to combat creeping weeds by attempting to pull them out or by pulling off the stems and leaves. All of them possess underground stems, and these will continue to form new shoots. Chemical weed-destroyers are likewise useless against such weeds, as the underground stems are not reached by any but very heavy applications, such as would prevent any other plant from growing in the spot until the chemicals were removed.

Annual weeds that form a rosette of leaves like shepherd's-purse and whitlow-grass are easily weeded by hand or they may be destroyed by chemical sprays. Such weeds are, however, rarely troublesome, and then mainly in old run-down or neglected greens or on poorly seeded new greens.

Common chickweed sometimes appears as a weed on greens in early spring or southward in winter. It rarely causes any serious trouble. Where abundant it may be destroyed without injuring the grass by spraying with a solution of arsenite of soda, using eight pounds to fifty gallons of water.

Summer annuals, especially the weedy grasses, goose-grass, pigeon-grass, and crab-grass, often are extremely troublesome and very expensive to control. At the present time the only practical method of destroying them is hand-weeding, which should be commenced as soon as the weeds are large enough to pluck. Where they are abundant, however, this requires a large force of laborers.

As is well known, all these weedy summer grasses are at once killed by a heavy frost. Attempts have been made to devise a satisfactory machine to kill them by freezing, but thus far the expense of the necessary portable refrigerating machine has been prohibitory.

In the construction and maintenance of putting-greens, every effort should be made to prevent weed seeds from becoming scattered on the green. With proper bunkering, few weed seeds should reach the green through the agency of the wind or by wash-

ing during heavy rain storms. Fertilizers used as top-dressings should be weed-free. Particularly is this true of barnyard manure, which should never be used unless it has been carefully composted for at least one year. Otherwise the advantage of such a top-dressing is largely counterbalanced by the great number of weeds introduced. On properly protected greens the expense due to weeding should by thorough work become less each succeeding season.

The use of ammonium sulfate to destroy certain weeds, especially White Clover, is often advocated. The evidence indicates clearly that on plots heavily and persistently fertilized with this substance, White Clover does tend to disappear. This is due partly to the fact that the grass is stimulated far more than the clover, but perhaps also to the chemical really injuring the clover. However, sulfate of ammonia is a very caustic substance, and great care must be exercised in applying, as an overdose will scorch grass badly.

White clover (*Trifolium repens*). — This plant (Plate VII) is too well known to require description. It is a common constituent of lawns everywhere in the United States except the extreme South, coming

spontaneously if not planted. On fairways it is not at all objectionable, but really desirable. On putting-greens it occurs too commonly, and while it provides a fair putting surface, it is inferior to the fine grasses. Cutting out the sod where it occurs is a radical and indeed the only satisfactory method of eradication, but one rarely adopted.

Mouse-ear chickweed or "*Creeping Charley*" (*Cerastium vulgatum*). — Mouse-ear chickweed (Plate XVII) is a European plant abundantly established as a weed in American pastures and lawns. It is unfortunately often found as an impurity in commercial fine grass seeds. From this source it becomes commonly established in putting-greens. The plant is readily distinguished by its oblong entire hairy leaves in pairs on the stems. It prefers well-drained soils. The plant does not make a good turf, and it is in every way objectionable. When young, the plants can sometimes be wholly removed by careful weeding, but usually it is best cut out bodily and replaced by a patch of good turf.

Yarrow (*Achillea millefolium*). — Yarrow (Plate VII) is native both to Europe and America. A small proportion of seed as an impurity is not uncommonly found in fine grass seeds. It is mainly

from this source that it finds its way into putting-greens, but in many places it may come from native plants, as the seeds are very light and easily blown about. Adult plants are two to five feet high, but on putting-greens individual plants make a dense mat often a foot or more in diameter. Such turf makes a fairly satisfactory putting surface, not as good as fine grasses, although some golfers have advocated its use for putting-greens. Under putting-green conditions, yarrow never spreads except as the individual plants become larger, as there is no opportunity for it to form seed. To eradicate yarrow, the turf must be removed bodily.

Sheep sorrel (*Rumex acetosella*). — Sheep sorrel is a very well known weed, especially abundant in poor pastures, but very frequent in lawns and greens. The seeds unfortunately often occur as an impurity in fine grass seeds. Sheep sorrel is in every way an objectionable weed on putting-greens. It may sometimes be pulled out by hand-weeding, but usually it is necessary to lift the piece of turf, as the rootstocks are deep and tough. Sheep sorrel is often considered to be an indication of "acid" soils, but this idea probably arose as a psychological confusion, the plant itself being

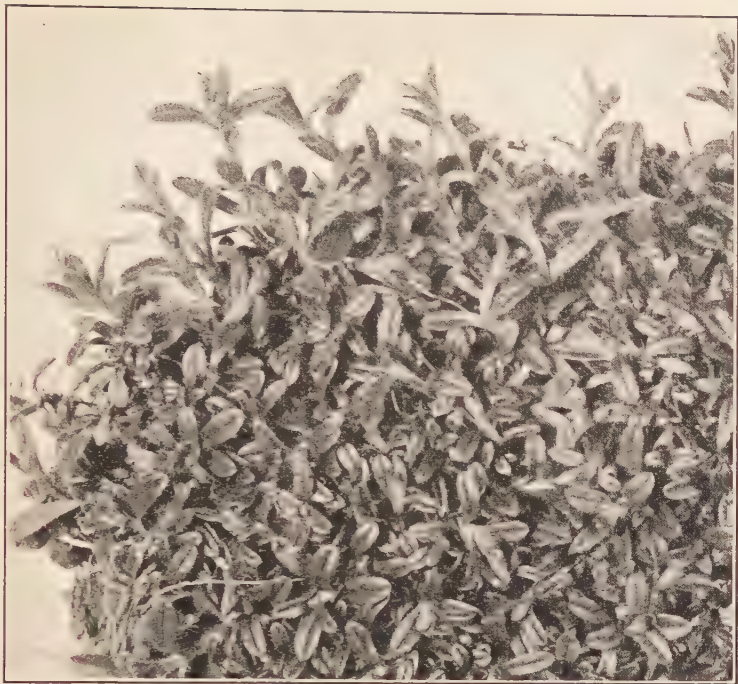


PLATE XVII. — Upper. Mouse-ear Chickweed or “Creeping Charley” (*Cerastium vulgatum*), natural size, one of the commonest troublesome weeds on putting-greens. The seed is often present as an impurity in fine grass seeds.

Lower. Creeping Thyme (*Thymus serpyllum*), twice natural size. This weed makes a fairly good putting surface but detracts from the beauty of a green.

acid. Sheep sorrel will thrive even where lime is abundant.

Pearlwort (*Sagina procumbens*). — This little plant (Fig. 41) has narrow leaves and much resembles grass turf. It is dark green in color and makes circular patches two inches to nearly a foot in diameter. The older patches tend to die out at the center. The flowers and seeds are produced

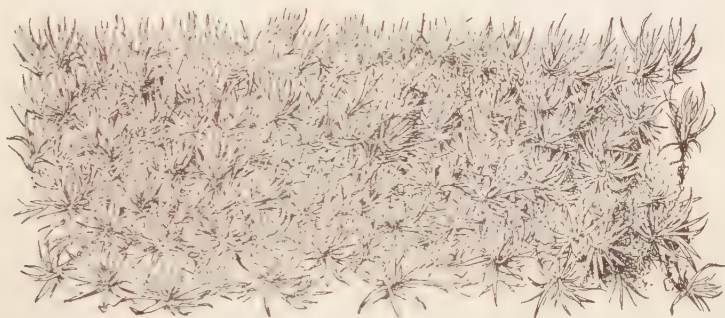


FIG. 41. — Pearlwort (*Sagina procumbens*), troublesome mainly on northern golf courses.

close to the ground, so that after the plants have matured, the seed becomes scattered about in mowing and watering the green. Pearlwort thrives especially in greens that become soggy, but occurs even where the drainage is satisfactory. In some cases it spreads so as to make up a very considerable element of the turf. As a putting surface it is only fair, the leaves being too succulent. Cutting out

is the only satisfactory remedy known, and this should be done as soon as the plants are detected, as otherwise the seed will become spread over the green.

Thyme-leaved speedwell (*Veronica serpyllifolia*). — This plant (Fig. 42) is native to Europe and perhaps also to America. It occurs very commonly as a



FIG. 42. — Thyme-leaved speedwell (*Veronica serpyllifolia*). Often abundant on poorly drained putting-greens.

weed, especially in moist or ill-drained pastures and lawns. When closely clipped the plant makes a dense mat, a single plant often forming a circle two or three feet in diameter. It is rather too coarse for a good putting surface. Seed of it is not uncommon as an impurity in fine grass seeds, but where established it will form some seeds very close to the earth. Well-drained soils are not favored

by this plant; indeed its presence is always a clear indication of poor drainage. Cutting out the plants bodily is the only satisfactory method of eradication.

Creeping thyme (*Thymus serpyllum*). — Creeping thyme (Plate XVII) is a native of Europe, but now common in lawns and pastures in the northern states. Seeds of it not rarely occur in fine grass seeds. Perhaps of all the weedy plants, creeping thyme makes the best turf so far as putting is concerned. In grass turf, however, it is unsightly, even if its putting surface is not especially objectionable. It must be removed bodily to insure its destruction.

Carpenter-weed or heal-all (*Prunella vulgaris*). — This European plant (Fig. 43), a common weed in pastures and old lawns, is occasionally found



FIG. 43. — Carpenter-weed (*Prunella vulgaris*). Common in northern lawns and greens, the seed being a frequent impurity in grass seed.

in putting-greens. The seeds may occur as an impurity in fine grass seeds. While the plants will make a dense creeping turf, the leaves are too coarse for putting purposes. Lifting the turf occupied by this weed is the best practical way to destroy it.

Water pennywort (*Hydrocotyle americana*). — This introduced plant (Fig. 44) much resembles ground

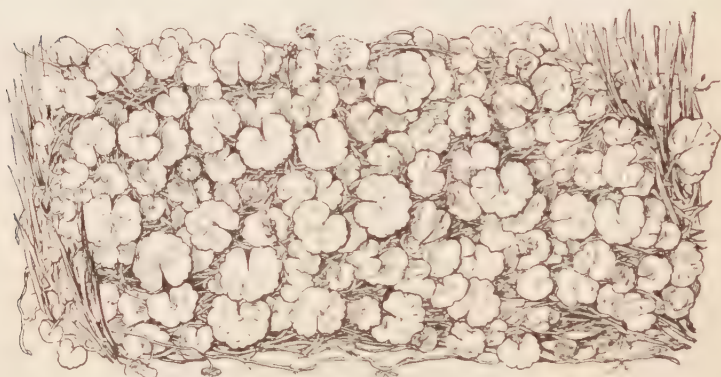


FIG. 44. — Water pennywort (*Hydrocotyle americana*), a common turf former in ill-drained soil.

ivy, but the leaves are smooth, shiny, and somewhat fleshy and the flowers are very small and inconspicuous. Its occurrence in a lawn or green is an indication that the soil is so moist as to need drainage.

Ground ivy (*Nepeta hederacea*). — This creeping plant often forms extensive patches in lawns and

occasionally on putting-greens. It is native to Europe but is now a common plant in America, often occurring in abundance in shady woods near towns. Its peculiar leaves, and when in bloom its numerous blue flowers, make it easily known. It thrives under close clipping, but does not make a good putting turf. To destroy ground ivy it must be removed completely by lifting the turf so as to secure all the underground creeping stems.

Selaginella (*Selaginella apus*). — This is a native moss-like plant with yellowish green foliage. Its occurrence in putting-greens is always evidence that the drainage is poor, as selaginella grows only in springy places.

Dandelion (*Taraxacum officinale*). — This weed is familiar to all. On account of its large tap-root it is almost impossible to dig it out completely without injury to the grass turf. It may easily be destroyed, however, by the use of gasoline injected into the crown of the plant with a sharp-pointed oiling can or by touching it with a few drops of sulfuric acid.

Plantain or rib-grass (*Plantago major*). — This is a very well known weed often found in lawns because its seed is a common impurity in grass seeds.

It is easily dug out or may be destroyed as recommended for dandelions.

Buckhorn (*Plantago lanceolata*). — This very common weed also becomes spread because its seed is so frequently an impurity in grass seeds. It may be destroyed in the same manner as plantain.



FIG. 45. — Goose-grass (*Eleusine indica*), a summer weed frequently invading putting-greens.

Goose-grass (*Eleusine indica*). — This summer grass (Fig. 45) is sometimes abundant, but never as troublesome as crab-grass. It is distinguished by its flattened stems and sheaths, the latter often whitish. Goose-grass makes circu-

lar patches two to six inches in diameter, but it has no creeping stems. It is easily removed by weeding.

Pigeon-grass (*Chætochloa lutescens*).—This grass (Fig. 46) is next to crab-grass the worst summer weed on putting-greens.

It may be distinguished from crab-grass as shown by Figs. 25 and 26.

Crab-grass (*Syntherisma sanguinalis*) (Fig. 47).—

Crab-grass is by far the most troublesome summer weed on putting-greens.

It appears in early summer and persists till killing frost in fall.

During early autumn when the nights become cool, the leaves assume a purplish hue. This grass



FIG. 46.—Pigeon-grass (*Chætochloa lutescens*), an annual grass often troublesome as a summer weed in putting-greens.

thrives only in the open and will not endure constant shade, a fact that unfortunately cannot be utilized

on putting-greens. Crab-grass spreads by stems which creep on the surface so that one plant will often make a mat one or two feet in diameter. It is often abundant enough, unless weeded out,



FIG. 47.—Crab-grass (*Syntherisma sanguinalis*). This is the worst of all summer weeds, especially in middle latitudes.

to occupy the whole green, in which case it is endured only as a matter of necessity (Plate VI). At the present time there is no satisfactory way to destroy crab-grass except by hand-weeding. This should be commenced just as soon as the plants are large enough to pluck.

Dichondra (*Dichondra repens*).
—This plant

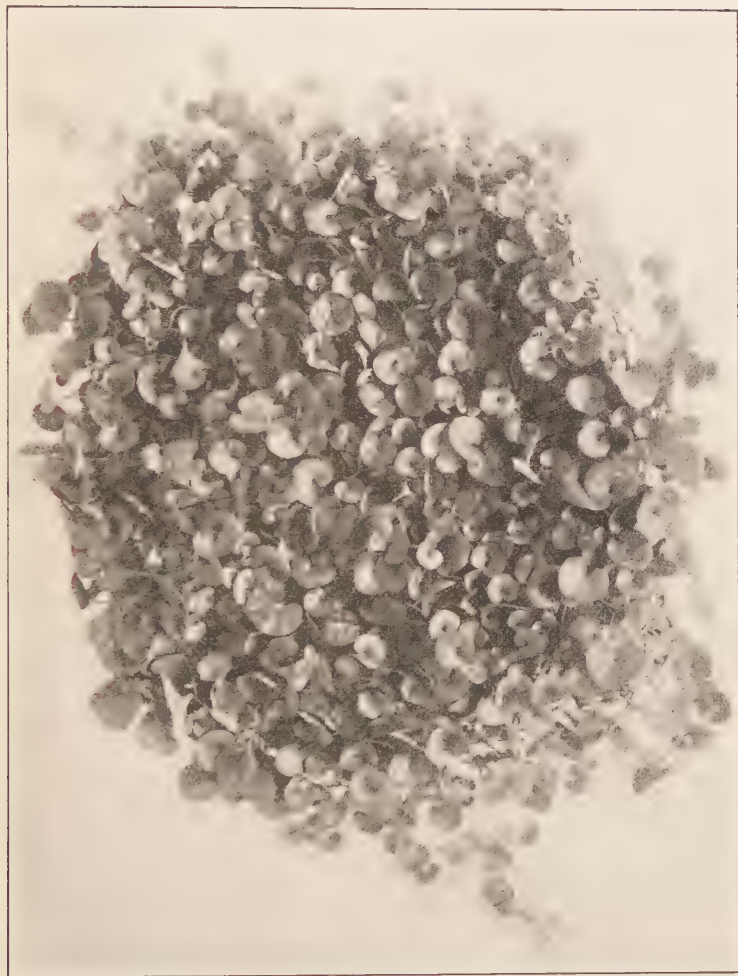


PLATE XVIII.—*Dichondra* (*Dichondra repens*), a common weed in the South in lawns and putting-greens. It makes turf of fair quality.

(Plate XVIII), which has no popular name, occurs in the South from Virginia to Texas, and is common in lawns and pastures. The plant is easily recogniz-

able by its kidney-shaped, rather pale green leaves, and by its close creeping stems.

The very small, pale green flowers appear in spring.

Dichondra is a very frequent weed in turf in the South.

On putting-greens it provides a surface as good or possibly slightly better than White Clover.

In Bermuda-grass, however, the pale green,

rather coarse foliage of the dichondra detracts from the appearance of the turf. To eradicate dichondra the plants



FIG. 48. — Nut-grass or coco (*Cyperus rotundus*). A grass-like weed with small tubers, very difficult to eradicate.

must be removed bodily by lifting the turf where it occurs.

Nut-grass or coco (Cyperus rotundus). — Nut-grass (Fig. 48) is really a sedge, and to the southern farmer a very notorious weed. The plant has slender, grass-like pale green leaves and grows to a height of two to twelve inches. Its weediness is due to its producing small underground tubers, which are exceedingly difficult to destroy. The plant also produces abundant seed. In fine turf, nut-grass is mainly objectionable on account of its pale green color, but the leaves are rather stiffer than is desirable for putting. On putting-greens it may be combated by hand-weeding, but it is exceedingly difficult to remove all the tubers with the plant.

CHAPTER XII

ANIMAL PESTS

INSECTS and other animal pests while less important than weeds on putting-greens are, nevertheless, a source of frequent annoyance. They usually are first-hand agencies in turf destruction, while weeds accomplish their injurious work somewhat indirectly. More attention has been given to weeds and methods of their eradication than to the control of worms, ants, moles, and other animal pests, but some very definite results have been accomplished in the case of the latter, and there is good reason to expect better results as more study is given the problems.

MOLES

According to the Biological Survey of the United States Department of Agriculture, there are in America at least five groups of true moles. Two of these are found in the Pacific Coast region, and three in the eastern half of the country. In Wisconsin, Michigan, New York, and the New Eng-

land states the star-nosed mole (*Condylura cristata*), and Brewer's mole (*Parascalops breweri*) are the most important species, while south of this general region the common mole (*Scalopus aquaticus*) is the one that is most prevalent.

In the spring especially, and at other times when the ground is soft, moles cause no end of annoyance on putting-greens. Their work is more evident, perhaps, than that of other animals, and doubtless quite as serious for the unit of area which they cover. Almost every one is familiar with moles and the external evidences of their work, but a great many mistaken impressions prevail with regard to their food habits and the purpose of their tunnels.

The moles do not eat grass or grass roots, or, in fact, any vegetable matter, but restrict their diet almost solely to insects. Furthermore, the tunnels whose ridges are so prominent are not their living quarters, but are the results of their search for food. Frequently much of the trouble attributed directly to the moles is in reality caused by field mice or some other rodent which takes advantage of the former's runways to find grass roots and other vegetable food. Moles, however, after all, are responsible for the ridges on the greens, and, if

not properly treated, these ultimately result in streaks of dead or injured turf.

While moles are of some importance in killing injurious insects in the soil, their presence on putting-greens is not to be tolerated. Trapping is the only practical method of destroying them. The harpoon, scissors-jaw, and choker types of trap (Fig. 49) are very satisfactory if properly handled. The nature of the trap itself seems to be rather less important than the method of setting it. Successful operation depends very largely upon proper setting over the portion of the tunnel where the ridge is especially prominent, since this part of the runway is most likely to be frequented. Careful

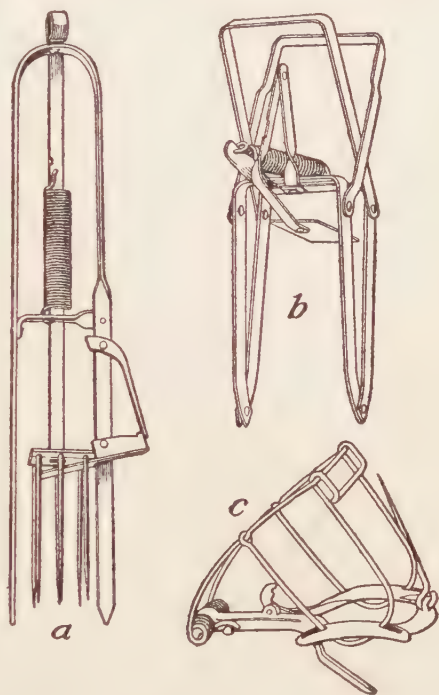


FIG. 49. — Mole traps. Three types that are effective.

observation soon will enable the operator to determine the best location. Ordinarily, the main line of the runway should be selected rather than one of its branches, as the latter are less commonly used. To set the trap properly, the course of the tunnel should be ascertained by the aid of a cane or small stick. This will permit the operator to place the trap in the best possible position with reference to the runway. It is found advantageous to push the spikes of the harpoon type of trap into the ground two or three times after the trap is set to break the way and provide against obstruction at the critical moment. Failure very often results from pressing down too much of the ridge. Only a small portion which is under the trigger should be depressed, and by the hand rather than by the foot. No other part of the runway should be molested. The manufacturers of the various traps always accompany them with detailed instructions for their operation, but nevertheless, close observation and a little experience on the part of the operator will contribute materially to the success of trapping.

Poisonous baits have never proved satisfactory. Moles are apparently too keen to be fooled with

anything of this sort, and even though they have neither external eyes nor external ears, they are shrewd enough to detect many kinds of danger, and doped food seems to be one of them.

While waiting for the trap to check the activities of moles, some steps should be taken to obviate the effects of their tunnels through the turf. Continuous use of the roller will prevent, or at least lessen, the injury to the grass, and also induce the moles to abandon their runways. However, the roller should not be used to the detriment of the adjacent turf.

Inasmuch as moles ordinarily work less than six inches below the surface of the soil, and upon meeting an obstacle in their paths turn to one side or the other rather than upwards or downwards, there is some reason to believe that they can be discouraged from invading areas of turf by surrounding the areas with a barrier which extends from the surface to a depth of twelve inches. Such a barrier could easily be constructed of boards or planks, and would be comparatively inexpensive. Experiments are now under way to determine the efficiency of various types and depths of barriers.

FIELD MICE

Field mice occasionally find their way to putting-greens, usually following in the tunnels of moles, although sometimes digging tunnels of their own. Fortunately, these animals are very easily exterminated by means of poisonous bait. The Biological Survey of the United States Department of Agriculture recommends the following for use on a large scale:

“Crushed wheat, treated with strychnine (alkaloid). Dissolve $\frac{1}{4}$ oz. of strychnine in 1 qt. of boiling water. Mix one tablespoonful of gloss starch in $\frac{1}{2}$ cup of cold water, and add to the boiling strychnine solution to make a thin mucilage. Following this dissolve $\frac{1}{2}$ oz. of bicarbonate of soda in $\frac{1}{2}$ a cup of hot water. Add to the poisonous starch and mix well. Add $\frac{1}{2}$ tablespoonful of saccharine. Apply the poison to 15 pounds of crushed wheat and mix so as to distribute evenly. This bait should be put in the runways which can easily be located by means of a blunt-pointed stick.”

Mice usually are not sufficiently abundant on the greens to warrant the preparation of a large quantity of bait, and in many cases a small quantity of simply prepared material is to be preferred. Poisoned sweet potatoes may be found very satisfactory, especially where two or three greens are

to be treated. The potatoes should be cut into pieces about one-half inch square and thoroughly washed and drained. On a quart of these pieces sift one-thirty-second of an ounce of powdered strychnine (alkaloid), and about one-tenth of this quantity of saccharine previously ground together. A piece of potato should be placed in the turf or tunnels in the manner suggested for treated wheat.

POCKET GOPHERS

Occasionally pocket gophers invade putting-greens and cause inconvenience and considerable damage. These animals can be trapped successfully, but poisoning is a much more satisfactory method of destroying them. The Biological Survey of the United States Department of Agriculture recommends the following method for preparing and using poisoned baits of sweet potatoes and parsnips so as to be most effective.

“The baits should be cut about an inch long and a half inch square, and washed and drained. From a pepper box slowly sift $\frac{1}{8}$ ounce of powdered strychnine (alkaloid) and $\frac{1}{10}$ of this quantity of saccharine (ground together in a mortar) over about four quarts of the dampened baits, stirring to distribute the poison evenly.

“The runways, which are usually 4 to 8 inches

beneath the surface, can be located by means of a probe made of any strong handle an inch in diameter and 36 inches long. One end should be bluntly pointed. Into the other should be fitted a piece of $\frac{3}{8}$ inch iron rod, protruding about 12 inches, and bluntly pointed. A foot rest aids in probing in hard soils. By forcing down this iron rod near gopher workings, or a foot or two back of fresh mounds, the open tunnel can be felt as the point breaks into it. The blunt end of the instrument is now used carefully to enlarge the hole, a bait or two is dropped into the run and the probe hole closed."

EARTHWORMS

Earthworms, of which there are numerous species in the United States, rarely, if ever, do any serious damage even to the finest turfs. In fact, they have a beneficial tendency, although their presence is probably of less importance to the soil than Darwin and others would lead us to believe. That they do aërate and cultivate the soil to a considerable depth is beyond question. They may also add some nitrogen through the decomposition of their bodies, but there is reasonable doubt as to their value in promoting the decay of organic matter and its subsequent utilization. One thing, however, is certain — they are undesirable inhabitants of putting-greens.

Earthworms prefer clay and loamy soils, and are very much less troublesome in sandy soils. They commonly appear in considerable numbers during moist seasons on areas that are naturally inclined to be wet, and after continued heavy watering. The casts formed by earthworms are a source of great annoyance to the player, and make accurate putting practically impossible. These casts can be eliminated by brushing or sweeping, but such treatment does not lessen the activity of the worms.

Earthworms can best be eradicated from turf by the use of chemical solutions. One that is commonly used with almost uniformly good results is bichloride of mercury, one-half ounce to fifteen gallons of water. If this solution is sprinkled very freely on the greens, it will bring the worms to the surface where they can easily be swept up with a coarse broom and removed. Quicklime solution is also efficacious. To secure the best results from this, mix twenty pounds of caustic lime with forty gallons of water, and allow it to stand until the solution is clear. If the liquid is applied liberally to the infested areas, the outcome will be much the same as in the case of treatment with the bi-

chloride solution, but probably less pronounced. Another substance that has been well recommended is a fairly strong solution of acetic acid. A weak solution of ammonium carbonate also appears to be effective, but experience indicates that a solution of bichloride of mercury is the most economical and most dependable. There are on the market numerous proprietary compounds which have been extensively advertised for eradicating earthworms. Analyses indicate that with very few exceptions the poison in these compounds is mercuric chloride, either dry or in solution. One which is also advertised as a "plant-food" contains a vegetable poison. The proprietary worm-killers are very much more expensive than mercuric chloride and no more effective.

ANTS

The treatment for ants is quite different from that for earthworms, and is much more tedious and expensive. No matter what kind of solution is used, sprays are far from satisfactory. A few individuals, it is true, can be killed by spraying with the proper liquids, but the wholesale slaughter that is necessary to bring about extermination can only be produced by treating each nest separately.

Liquids, when sprayed, do not penetrate sufficiently deep into the nests to be effective, and even if numerous applications are made, the results are far from satisfactory.

Various solutions have been used and recommended for direct application. Of these, carbon bisulfide is probably the best known and most popular. This liquid is very efficacious, and for the ants that commonly infest putting-greens a comparatively small quantity is sufficient for each colony. There is no special apparatus on the market for applying it, but a common oiler, such as is used by mechanics for oiling engines and similar machinery, answers the purpose very well. The spout should be at least two feet long, with a curved end and a small aperture. If the oiler is equipped with a spring bottom, a squirt or two will be sufficient for each nest. Carbon bisulfide is readily volatile and forms a gas that is appreciably heavier than air. This being the case, it permeates the various lower chambers of the nests, killing almost instantly the ants with which it comes in contact.

Within recent years, potassium cyanide has been used for ant repression and promises to replace even carbon bisulfide on account of its efficiency

and low cost. One ounce of 98 per cent potassium cyanide to one quart of water is about the proper proportion. The two should be carefully mixed and the solution liberally injected into each ant hill by means of an oiler such as has been previously described. A second application may be necessary after a day or two, but even so, the treatment is cheap, practical, and productive of good results.

Neither carbon bisulfide nor potassium cyanide is harmful to the grass, and may be used with impunity. The former, however, is highly explosive, and the latter is very poisonous to animal life. A little ingenuity should develop a simple and inexpensive piece of apparatus that would be far superior to the oiler for dispensing these liquids. A long glass tube fitted with a reservoir and plunger, something after the fashion of a large compound syringe, could be made to force the desired quantity of solution to the extreme chambers of the ants' nests, thereby greatly increasing the effectiveness of the treatment.

GRUBS

In the larval or grub stage, the beetle commonly known as the June beetle (*Cotinis nitida*) frequently does serious injury to turf. It is particularly trou-

blesome in soil that has been heavily manured or well supplied with humus. The beetles, shortly after emerging from the ground during the late spring and summer, bore back into the soil to a depth of several inches and lay their eggs. It requires but a short time for the eggs to hatch, and the young grubs to become active. These grubs tunnel through the soil and feed on the humus contained in it. When their tunnels come to the surface, as is commonly the case, the larvæ throw out small piles of earth which resemble ant hills. The grubs continue feeding on the humus in the soil until cold weather commences. They are then about two-thirds their full size. At this time they burrow into the soil to a depth of several inches, and as they throw up considerable quantities of earth at the mouths of the burrows, their presence is soon noticed. The grubs do not become entirely dormant during winter, and with the advent of warm days resume feeding. By the last of June they have ordinarily completed their life's cycle. The injury done by the grubs results from the loosening of the turf when they are actively feeding in the soil.

A few treatments have been recommended and

seem to be fairly efficacious. The application of carbon bisulfide by means of a large oiler or syringe has given very satisfactory results but is a tedious method. Some greenkeepers have found it practicable to kill the grubs by means of a rod about one-fourth inch in diameter. The openings in the ground made by the grubs can be seen, and if the rod is pushed into them, the grubs can in many cases be killed. This method is also tedious, but it is considered by some to be more satisfactory than poisoning with carbon bisulfide. Excessive watering frequently brings the grubs to the surface so that they can be killed by hand. This method is very slow and not very practicable. In some cases it appears that heavy rolling stops the activities of the larva and prevents injury to the turf. If this method can be depended upon, it is the most feasible one so far devised. Since the beetles seem to infest only areas that have been heavily treated with manure, it is suggested that the use of humous fertilizers be discontinued where the grubs appear, and that further applications should be of inorganic fertilizers or bone-meal.

CRAWFISH

On poorly drained greens, especially in the South, crawfish, also known as crayfish, are sometimes very troublesome and destructive. The soil which they throw up from their burrows interferes with play, and definite injury results to the grass from the work of these animals. The most effective remedy for crawfish is to lower the water table materially by deep tile drains, or some other effective means. This should be done, if possible. Poisons afford temporary relief and if used continuously prove very effective. Carbon bisulfide is the most satisfactory poison that has been found. If a small quantity of this liquid is placed in the burrow and the opening immediately closed, the gas which develops will kill the crawfish in a few hours. An oiler with a long spout, having a small aperture, can be used for dispensing the poison. One squirt to each hole is sufficient. Chloride of lime and certain other poisons are cheaper than carbon bisulfide, but they are less effective.

CHAPTER XIII

TURF MACHINERY

THERE is now a wide variety of machinery designed largely, if not wholly, for the care of greensward. These machines include mowers, rollers, sprinklers, and the like, each of many types. There exists, as is natural, much difference of opinion as to which particular machine of each kind is most satisfactory. It is proposed here to discuss the subject only in a general way, and not to enter into the merits or defects of especial makes of machines.

SEEDERS

It is often desirable to thicken or to better the stand of grass on putting-greens or fairways without interfering with play on the existing turf. If the seed be broadcast on the surface, it may be raked gently to bury it slightly, or a thin layer of good loam scattered upon the seed, to insure germination. In either case this interferes with play, especially upon the putting-greens.

In the illustration is shown a "cut-in seeder" (Plate VIII) especially designed for use on turf. With this the seed is dropped in the narrow furrows cut by the disks, so that the seed is well placed for germination. The disks do not injure the turf noticeably, especially if after their use the green is rolled with a light roller. Much better results are ordinarily secured with this machine than by other methods.

SPIKED ROLLER

The illustration (Fig. 29) depicts a very useful implement for treating turf previous to top-dressing or even to seeding. The spikes make numerous small depressions into which most of the applied material finds its way, especially if the turf be raked afterwards with the back of a rake, or swept. This implement is not well known, but there are many places on a golf course where it can be used advantageously.

SPRINKLERS

Numerous types of water sprinklers are in use. For the watering of putting-greens it does not appear that any one of them has a decided advantage over the others. Perhaps the one point in which a sprinkler may really excel is the area of ground that

it will water from a given place, and thus save labor in moving it about. On the other hand, with a fixed supply of water the amount sprinkled to each unit of area in a given time will decrease as the area covered increases.

It is generally believed that watering is most effective when large amounts of water are applied at rather long intervals, which is precisely what any sprinkler does not accomplish. There is no satisfactory evidence to show, however, that flooding a green with a solid stream has any particular advantage over sprinkling. Indeed, where the soil is more compact than is desirable, or where the green slopes much, slow sprinkling is preferable, as the water penetrates the soil more rapidly under such conditions after the surface soil has become well wetted. On sandy soils which absorb water quickly, flooding is perhaps preferable to any system of sprinkling.

On the whole, the question of method or machines used in watering does not appear to be of any particular importance. The really essential point is to water heavily at rather long intervals — the length of interval depending on the character of the soil, the amount of surface drainage, and the weather.

A preliminary light sprinkling to moisten the surface soil is usually desirable before watering heavily.

ROLLERS

Rollers for use on a golf course differ mainly in their respective sizes and weights. There are on the market, however, rollers which may be increased or decreased in weight as required. An excellent type of such a roller is constructed to contain water, the weight being controlled by the amount of water used.

Generally speaking, heavy rolling on clayey soils is injurious, except when used at considerable intervals; while on sandy soils it is never injurious and usually desirable. On clayey soils one heavy rolling early in the spring is to be recommended, while one or two more during the season when it may seem desirable will occasion no harm.

On putting-greens with soil of the proper texture, rolling should be just sufficient to secure a compact smooth surface. Heavier rolling than this is never desirable, although it may not cause any particular damage.

MOWERS

Mowing machines are most essential implements on every golf course. For use on fairways either

horse-drawn or gasoline motor machines are now used exclusively. Some of these machines are combined rollers and mowers. On level or gently undulating courses, the motor machines are most efficient. The only serious objection to them is their weight, which on clayey soils results in too great compacting of the surface soil, but this objection does not apply when used on courses with sandy loam soils.

When the soil on the fairways is clayey, horse-drawn machines are favored, because they are not so heavy as to cause undue compaction of the soil. The use of horses may involve some unevenness of the turf due to the footprints of the animals, but this can be largely obviated by mowing only when the soil is firm, or by using special shoes on the horses. Some of the horse-drawn mowers will cut at each passage a strip of turf seven feet wide, so that they are nearly as efficient as the more rapid-moving motor machines.

On putting-greens only small, light mowers should be used. Most of these are operated by man power, but there are available hand machines propelled by a motor, thus reducing the labor necessary to operate. A thoroughly satisfactory mower to cut the turf on putting-greens should be rather light, propel

easily, cut the grass close and evenly according to adjustment, and catch all the clippings. All of these requirements are fairly well met by machines now manufactured.

CARE OF MACHINERY

The efficiency of any machine depends on keeping it in as nearly perfect condition as is practicable. Many golf clubs find it profitable to have all of the machinery kept in order by the man best suited for the purpose, and forbid any other employee from adjusting a machine in any way. By this means the different machines used are kept as uniform as possible. In the case of mowers this is especially desirable, as otherwise the various machines operated would leave the turf in very different conditions of play.

CHAPTER XIV

EXPERIMENTAL WORK ON GOLF COURSES

SCARCELY any two golf courses are sufficiently similar so that one may confidently affirm that the methods found satisfactory on one will apply to the other. Nearly every golf course is confronted with turf-growing problems that it must solve for itself.

The experience in golf course management has not resulted in much increase of accurate knowledge so far as turf-growing is concerned. Every putting-green on a golf course has in most cases been subjected to so many kinds of treatment that it is impossible for any one to determine just which factors were good and which were bad. Add to this that the exact record of the history and treatment of a particular piece of turf is rarely preserved by any golf club, and it is not difficult to understand why there is so great difference of opinion as to what is desirable and what undesirable in growing turf in a particular region.

Even with so simple a matter as the effect of liming on different turf grasses, there is wide divergence

of belief. In such matters opinion is of no value unless backed by the results of definite experiments. On most putting-greens either all the area was limed or else none of it was limed. In either case there is no opportunity to draw definite conclusions because there is no basis for comparison.

Every field experiment either with turf plants or others, to be of definite value, must contrast a particular treatment with the absence of that particular treatment, the latter serving as a check to determine the value of the treatment. Furthermore, the experiment to be useful must be simple. For example, if a plot be treated with lime alone and checked by a similar plot without lime, a clear and definite conclusion may be drawn; but if the first plot be treated with both lime and fertilizer, it will be impossible to determine to which of the two the effect secured was due.

In the accompanying two diagrams are plans for two simple types of experiments involving problems of interest and importance to every golf course. Similar experiments are easily planned to bear on any problem that presents itself. It cannot be emphasized too strongly that only such definite experiments will really answer any problem or question for

any particular club. Soils and climatic conditions vary so greatly that there can rarely be full assurance that the results secured in one place apply generally. From the standpoint of economy alone, every golf club should experiment in a small, but definite, way to learn which methods are satisfactory and which unsatisfactory under its conditions. Until this is done, its greens committee will be continuously in doubt because the counsel it receives will be so diverse. Most of the advice given in such cases is mere opinion, but of the sort that nothing but careful experiments can shake.

When different fertilizers are compared, the best experimental method is to use them in quantities so that the amount of the element tested is the same for each plot; or so that the amounts of each of the three essential elements — nitrogen, phosphorus, and potash — are the same. For many commercial fertilizers these proportions are shown in the accompanying table, from which one may determine the amount of each to use where fertilizers are to be compared. Thus ten pounds nitrate of soda, eight pounds sulfate of ammonia, thirteen pounds tankage, and twenty-three pounds cottonseed-meal each contain equivalent amounts of nitrogen.

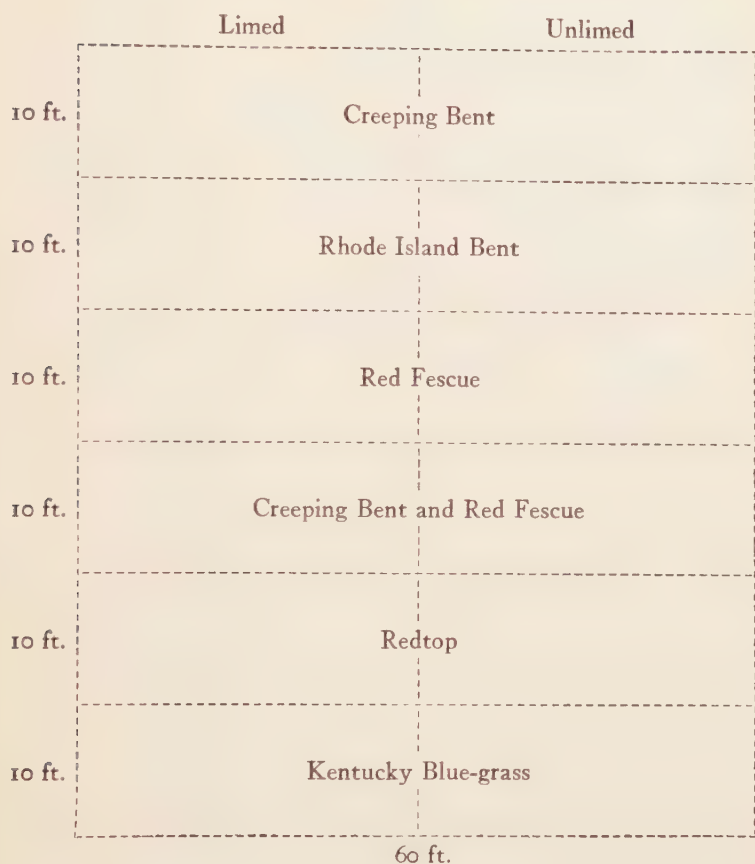


Diagram of a simple experiment to determine the effects of lime on a series of turf grasses, the soil treatment to be identical except that on one-half of each grass plot ground limestone is to be applied at the rate of two tons to the acre, either before the grasses are sown or afterwards as a top-dressing.

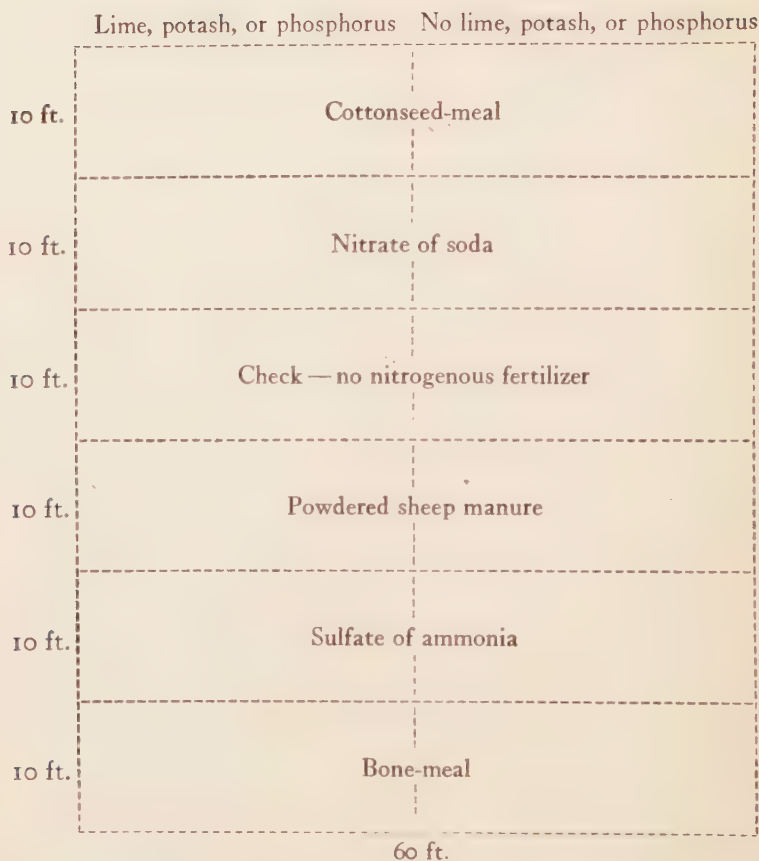


Diagram of a plot of Creeping Bent turf on which various nitrogenous fertilizers are being tested, the fertilizers being applied at the same time in amounts to give equal quantities of nitrogen. If desired, one-half of this plot could be treated with lime, phosphoric acid, or muriate of potash to determine the effect of this alone and combined with each of the others.

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The comparative testing of complete fertilizers, those containing nitrogen, phosphorus, and potash, is less simple. In case one wishes to compare the relative efficiencies of several kinds of mixed fertilizers on grass, one should consult the chemist of the state experiment station, as otherwise unsuspected errors and consequent false conclusions may be reached.

TABLE SHOWING AVERAGE PERCENTAGE OF NITROGEN, PHOSPHORIC ACID, AND POTASH IN VARIOUS FERTILIZERS

FERTILIZER	NITROGEN	PHOSPHORIC ACID	POTASH
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Nitrate of soda	16		
Sulfate of ammonia	20		
Cottonseed-meal	7	1.5	2
Bone-meal—raw	4	20	
Bone-meal—steamed	2	25	
Sheep manure95	.35	1
Dried blood	13	1	.8
Tankage	12	1	
Hoof-and-horn-meal	13	5.5	
Com. grade acid phosphate . .		14-16	
Muriate of potash			44-57
Sulfate of potash			47-52

NOTABLE FINE TURF INVESTIGATIONS

Olcott's turf-garden.—In the testing and selection of fine turf grasses, a notable body of work was conducted by J. B. Olcott at South Manchester, Con-

necticut, under the auspices of the Connecticut Experiment Station. This work was carried on from 1885 until the time of Olcott's death in 1910. The appearance of this notable grass turf-garden is shown on Plate XIX. Olcott's method was the simple one of continued search for plants that approached his ideal of perfection. In the course of his labors he visited hundreds of localities in America and Europe, as well as Hawaii, New Zealand, and Australia. Whenever or wherever he found a piece of turf that appealed to his taste, he carried it to his home where it was patiently propagated until enough was secured to plant a plot large enough to judge of its merits in comparison with others. In some plots grasses were grown from seed, but Olcott found that most of these showed much variation between individual plants, even when grown from a supposedly pure strain, so that eventually he propagated all his turf grasses by division, never allowing them to produce seed. During the life of its creator, the Olcott turf grass garden was one of wonderful interest. It contained nearly 500 strains of grasses, the choice out of the thousands that had been tested. The plots of turf were mostly about four feet square, but a few much larger, every plot being grown by the

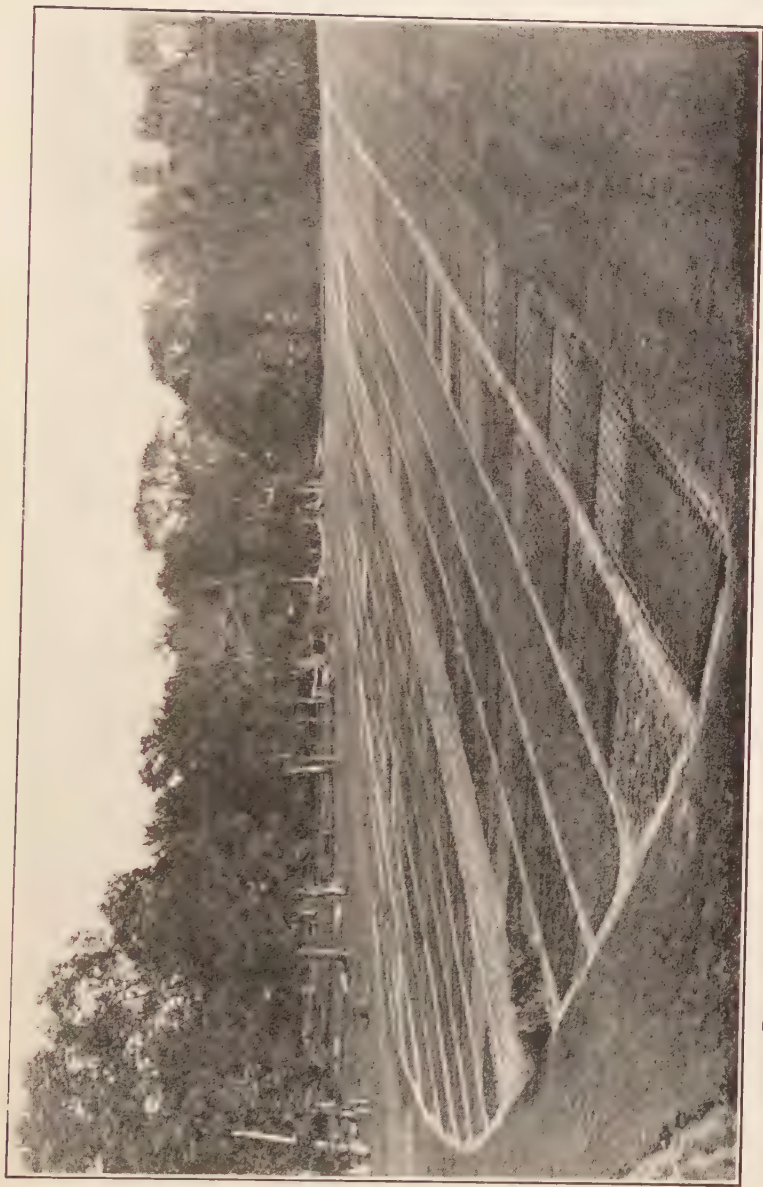


PLATE XIX. — A view of the Olcott grass turf garden at South Manchester, Connecticut.

vegetative division of a single original plant. Viewed as a whole it resembled a great checkerboard of different tints of green. Each plot received all the care that expert gardening skill and passionate devotion could give. This involved frequent clippings, trimming of the border so that one grass would not invade adjacent plots, and particularly hand-weeding, as some weed seeds were always being carried by the wind or otherwise to the garden. For weeding purposes, Olcott devised many ingenious tools. Each plot represented, therefore, the best possible turf that the particular strain of grass could produce. Olcott soon reached the conclusion that no other grasses could produce in New England turf of higher quality than did Creeping Bent and Red Fescue. Between these two grasses it is hard to decide, as in each there are strains that vary from pure pale apple green to the deepest emerald green. To the hand Red Fescue feels rather stiff and wiry, whereas Creeping Bent is soft, but each will produce a turf that under foot feels like soft velvet carpet. The dark green strains appeal to most persons as the ideal color for lawns, and the very dark green strain of Red Fescue makes probably the most beautiful turf of all temperate zone grasses.

While Olcott possessed the genius to select the grasses and grow to perfection the finest turf that had ever been produced, he lacked the ability to induce persons who could afford it to grow such lawns about their houses. Or perhaps the time had not come to interest the American public in his idea.

After Olcott's death the finest pieces of his turves were purchased by F. W. Taylor and transplanted to his home at Highland, near Philadelphia, where they furnished the basis of much of Taylor's subsequent work.

The Fred W. Taylor method of making putting-greens.—In many ways the most extensive and remarkable series of turf experiments ever undertaken were conducted by Fred W. Taylor on his home grounds near Philadelphia. These experiments were begun in 1904 and were continued until Taylor's death in 1915. Just before his death, Taylor prepared a series of articles in which were set forth some of his results and the conclusions he had drawn from his work. The articles were published in the "American Golfer," December, 1914, to June, 1915, inclusive, and in "Country Life in America."

Taylor, whose work on scientific management is well known to all, believed thoroughly in standardi-

zation, and, being an enthusiastic golfer and a keen student of the game, soon realized the lack of system practiced in the making of putting-greens. Purely from the love of the sport, he undertook his experiments with the firm belief that greens could be made in much the same way that an article is manufactured in a machine shop or factory. He believed that careful study would reveal the specific requirements for fine turf, and that these requirements could be met by the use of standardized materials. It may be said in passing that, at the outset at least, he greatly underestimated the importance of the factors affecting turf production which cannot be controlled.

The results of Taylor's preliminary experiments, which involved hundreds of plots and tests, led him to the basic conclusions which many other investigators have reached, that the chief essentials for good turf are good seed of suitable grasses, a good medium for the germination of the seed and the development of the seedlings, and fertile soil having a high water-holding capacity, and at the same time providing perfect drainage. With these conclusions fairly in mind, Taylor sought to construct the ideal green by selecting his grasses and actually building a medium upon which they were to be grown.

Among the first experiments which he conducted were those in which various germinating media were tested. He finally selected peat moss, a material that is imported in quantities from Holland, and which is also found abundantly in this country. To twelve parts of shredded peat moss he added one part of powdered bone, and with these he mixed the grass seed at the rate of 2000 to 5000 to 1. He found that when such a mixture is saturated with water and spread on a properly prepared surface, a uniform and thoroughly satisfactory stand of grass resulted.

This germinating medium possesses several valuable qualities. It has a high water-holding capacity, it does not compact, and is sufficiently open to admit of a free circulation of air. Furthermore, it is practically sterile so far as weed seeds are concerned and, on the other hand, contains enough nourishment for the seedlings. His method of seeding greatly reduces the quantity of seed necessary to secure a stand, but this pecuniary advantage was more than offset by the increased cost.

The germinating layer, as Taylor called it, embodied a new application of old principles to the seeding of putting-greens, and was, perhaps, the

most important feature that developed from his investigations. His experiments with soil layers and mixtures were almost without number. He hoped by testing the physical properties of various elementary soil substances to be able to construct a soil that would supply the optimum quantity of water to the grass plants at all times, and also contain plant-food at the proper depth.

Wicks of soil leading from a constant water supply up to a moisture-holding layer, rich in plant-food, were tested, but many important modifications were necessary in the subsoil feature before he hit upon a combination that suited him. However, the water-holding food layer was developed early in the history of his tests. In this connection Taylor finally decided to use two layers, which he termed the upper and lower blanket layers, the former resting upon the latter and lying immediately under the germinating layer. The upper blanket layer varied from nine-sixteenths inch to one and one-sixteenth inches in thickness, and was composed of twelve parts by volume of shredded peat moss, six parts by volume of powdered limestone, and one part by volume of powdered bone. The lower blanket layer was three-fourths inch in thick-

ness and was composed as follows: Shredded peat moss by volume, twelve parts; Powdered limestone by volume, twenty-one parts; Cow manure by volume, five parts; Bone cracked to one-fourth inch size by volume, three parts; Powdered bone by volume, one part. Other combinations were used in making the blanket layers, but Taylor considered this the best. In his opinion the upper layer had two important functions, namely, to promote rapid growth of the young plants, and to provide a springy surface, properly to check the ball on the approach shot. His chief reason for making a difference in the composition of the two layers was to provide suitable firmness. He believed these two layers to be almost ideal for the development of the surface roots, and for furnishing proper texture to the green.

Taylor conducted a great many tests before he found a subsoil that met with his requirements. Early in his experiments it became necessary to abandon the idea of sand or soil wicks to conduct water from a constant supply to the blanket layers. He also found it necessary to abandon the idea of a subsoil in which the greatest and deepest root development would take place, since the grass on such soils would not stand heat and drought. Clay, on the

other hand, he considered too impermeable, so he finally decided upon combined water-holding and permeability in one structure. Briefly, his foundation, or subsoil, was composed of alternate layers of two different compositions. It was intended at first to place these layers vertically, but this he

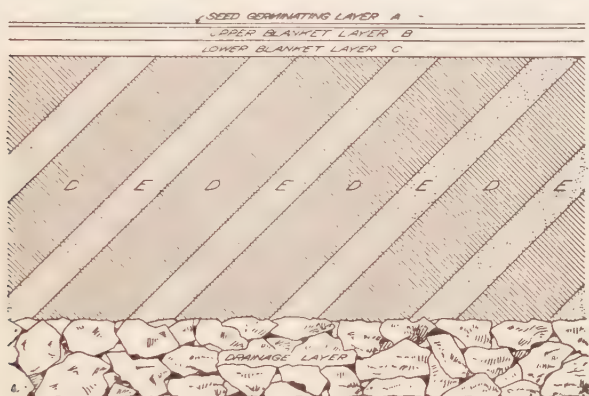


FIG. 50. — Diagrammatic cross-section of the soil layers of a putting-green constructed according to the method most approved by F. W. Taylor.

found to be impracticable, so he conceived the idea of laying them at an angle of about forty-five degrees, and on account of the diagonal position he called the layers “slants.” The so-called moisture and food slant was composed of a mixture of three parts clay and one part cow manure, and was about three inches in thickness. The other slant was composed of decayed peat moss, chopped in a feed chopper and

mixed with cow manure at the rate of nine parts of the former to one of the latter. This slant was called the deep-rooting layer, and was one and one-half inches in thickness. For convenience of laying, the materials for these slants were mixed and molded into rectangular slabs of suitable dimensions. When placed in position they had a vertical depth of twelve inches. (Fig. 50.)

The slants, in Taylor's opinion, furnished an excellent medium for the development of grass roots, for supplying food to the plants, and for absorbing and holding moisture; in addition to these qualities, they provided excellent drainage. With a twelve-inch slant section, followed by a lower three-fourth inch blanket layer, then an upper blanket layer from nine-sixteenth inch to one and one-sixteenth inches, and finally a three-sixteenths inch germinating layer on the surface, all of which contained large quantities of peat and manure, it readily will be seen that the soil of Taylor's greens was composed very largely of organic matter which, together with the other materials and the methods of construction, made the building of a green after his plan unusually expensive. According to his own estimates the cost of constructing a green of average size would be

approximately \$2500. However, he did not consider this prohibitive and, in fact, believed his method, in the last analysis, to be an economical one.

In discussing the requirements of a putting-green, he says in one of his articles on the subject: "The most important element is, of course, the soil which will ultimately allow the roots to go deep below the surface. If you have a natural soil of this sort, then I look upon germinating the proper number of seeds per square inch in the peat moss germinating layer as the next most important. Third comes the upper peat moss and limestone blanket layer, and fourth, the lower blanket layer. So much can be accomplished at a small cost through the use of peat moss germinating and blanket layers that no new green should be built without them. The writer places these three elements ahead of the artificially slanted layer soil because their cost is insignificant compared with the latter. If, however, fine results are desired within a few years after making a green, all of these elements are necessary. At the end of six years after making one of our greens, the original cost, plus the annual expense of maintaining it, will be less than that of a green under the usual way."

Even a casual glance at Taylor's method of green

construction reveals several unique features, some of which are not in accord with the orthodox views on the subject. For example, the germinating and blanket layers contain large quantities of bone and pulverized limestone. Bone is objected to by many because of its influence on White Clover, and lime is thought to be prejudicial to the best development of the bent grasses and Red Fescue. Such a large percentage of organic matter as Taylor's plan calls for is commonly objected to on the ground that it decomposes, causing uneven settling, and also on other grounds.

It is not intended here to enter into a defense or a criticism of Taylor's method. Fortunately he personally supervised the making of four greens according to this method on a new course near Philadelphia, and many new greens in other parts of the country have been built after it, so that it will in time develop its own advantages and weaknesses. This opportunity, however, cannot be missed to express appreciation of the motive which prompted Taylor's work, and of its value in stimulating much needed critical turf investigations.

CHAPTER XV

PERSONAL EXPERIENCES

AMONG the golfers of the country are many who have devoted much of their time and energy to a study of the problems involved in growing good turf. The experience of every one of these men contains much of interest and value to all who are concerned with similar work. Some golf clubs have been so remarkably successful in securing and maintaining good turf that they have attracted visits from many greenkeepers and others confronted with a like task. It is usually good economy for a club to send its greenkeeper or the committee in charge of the course to make such visits, as much valuable information is thus secured and many costly errors may be avoided. The experiences of three ardent golfers who have had much success in growing turf are presented here in their own words. It will be noted that in some details these gentlemen reach variant conclusions, but in the main their results are in close concord with the body of this book.

PRACTICAL EXPERIENCE IN GROWING TURF ON GOLF
COURSES NEAR PHILADELPHIA*Hugh I. Wilson*

The Merion Cricket Club, of Philadelphia, played golf on leased property for nearly twenty years and, as is usual in this country, the land became so valuable that the club was forced to move. This experience showed the advantage of permanency, so early in 1911 the Club appointed a committee consisting of Messrs. Lloyd, Griscom, Francis, Toulmin, and Wilson to construct a new course on the 125 acres of land which had been purchased. The members of the committee had played golf for many years, but the experience of each in construction and greenkeeping was only that of the average club member. Looking back on the work, I feel certain that we would never have attempted to carry it out, if we had realized one-half the things we did not know. Our ideals were high and fortunately we did get a good start in the correct principles of laying out the holes, through the kindness of Messrs. C. B. Macdonald and H. J. Whigham. We spent two days with Mr. Macdonald at his bungalow near the National Course and in one

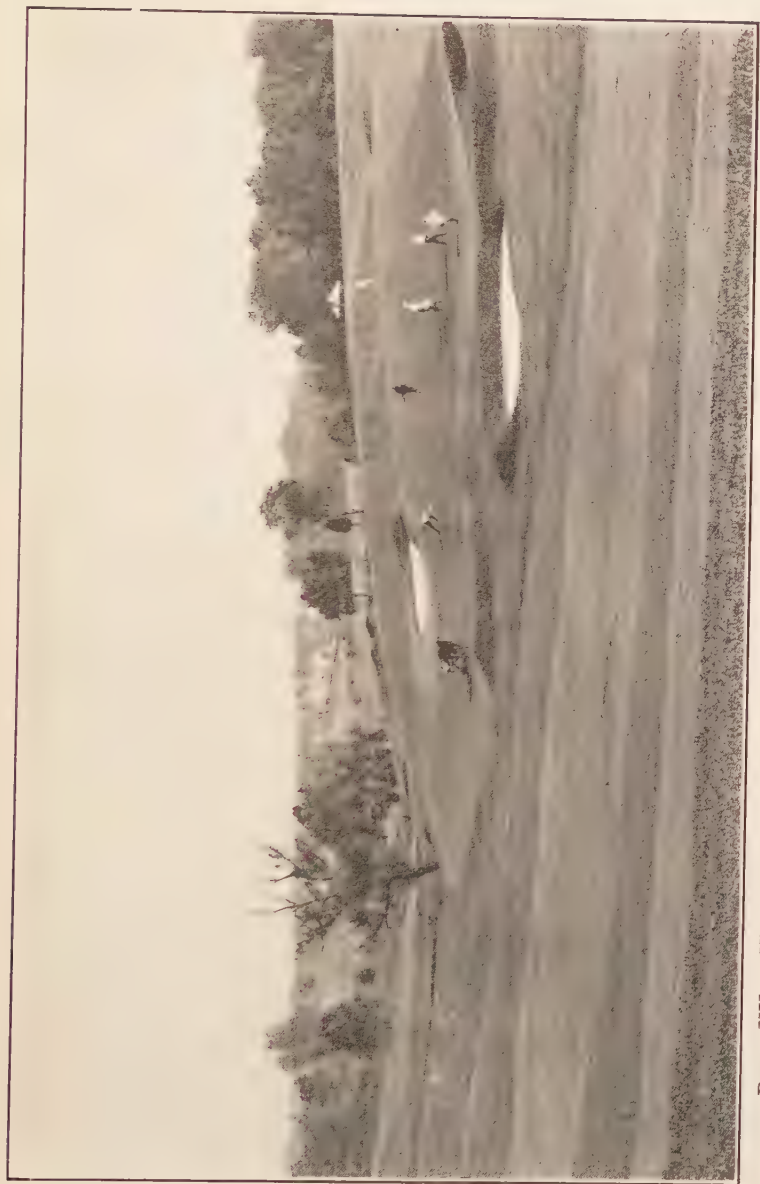


PLATE XX. — View of a golf course showing the closely clipped turf on the fairway and on the margins
the taller grass of the "rough."

night absorbed more ideas on golf course construction than we had learned in all the years we had played. Through sketches and explanations of the correct principles of the holes that form the famous courses abroad and had stood the test of time, we learned what was right and what we should try to accomplish with our natural conditions. The next day we spent going over the course and studying the different holes. Every good course that I saw later in England and Scotland confirmed Mr. Macdonald's teachings. May I suggest to any committee about to build a new course, or to alter their old one, that they spend as much time as possible on courses such as the National and Pine Valley, where they may see the finest types of holes and, while they cannot hope to reproduce them in entirety, they can learn the correct principles and adapt them to their own courses.

Our problem was to lay out the course, build, and seed eighteen greens and fifteen fairways. Three fairways were in old pasture turf. These will be mentioned later. We collected all the information we could from local committees and green-keepers, and started in the spring of 1911 to construct the course on ground which had largely been

farm land. We used an average of fifteen tons of horse manure to the acre on the fairways and eight tons of various kinds of manure to a green, the greens averaging about 10,000 square feet in area. At time of seeding, we added 300 pounds of bone-meal to the acre and 100 pounds to a green. After completing the construction of the greens, and thoroughly harrowing and breaking up the soil on both fairways and greens, we allowed the weeds to germinate and harrowed them in about every three weeks. We sowed from September 1 to 15 and made a remarkably good catch, due to two things — good weather conditions and a thorough preparation of the soil. We opened the course September 14, 1912, just a year after seeding, and it was in good playing condition. Naturally, the greens had not a finished surface. We found that it was very easy to get grass started, if weather conditions were normal, but experience has shown us how difficult it is to keep it in good shape. After we had one season's growth, one of the grass experts of the United States Department of Agriculture, when looking over the course, remarked that the writer should publish a book on the growing of grass. Being modest, I asked him for his reasons

and he replied, "Now you have definite fixed ideas as to what seed, fertilizers, and the like caused certain results, but each year your opinion will become less certain on account of the great number of factors which enter into the results." He was right, and it is truly difficult to give definite answers to many of the questions which bother those who are trying to grow turf. As one greenkeeper puts it, it is easy to grow grass but very difficult to get turf. Two months after opening our course, we were forced, on account of the increased interest in golf, to buy 125 acres more for another eighteen-hole course, which we started to build in March, 1912, and seeded in May. We were unfortunate in having a drought that summer, which burned out the fairways and by the end of August it looked as if we would have to reseed them all. Luckily, plenty of rain in September brought them back and they were in fair condition by May, 1913, when the course was opened. Naturally, this experience makes us prefer autumn seeding, and further experience has shown that in this section of the country it is the safer time. It may simplify this account if the experience is placed under headings.

Soil.

Ours is a clay loam, which would be called in this section a good farming soil. It is a fair lawn soil. Our fairways have grown well and have withstood drought with little damage. Our error in building the greens was a failure to open up the soil sufficiently and take care of the drainage. When we built them, they were all raised above the surrounding ground level so as to get good surface drainage and freedom from wash. We also forked in about eight tons of manure to a green and added about five tons of sand (not nearly enough) with a layer of leaf-mold, sand, and soil mixed in about equal proportions for the seed-bed. As was stated before, the results were good the first year, and it was not until the end of the second year that we noticed much deterioration in certain of the low-lying greens. In the fall of 1913, two years after seeding, the grass started to die in these greens and although we nursed them carefully, having noticed early in the summer that they were weak, all our efforts with fertilizer, water, and care were of no avail. Opinions differed as to the cause and treatment. Finally, we determined that as we could obtain a quantity of good turf from our old course, we

would dig them up and resod them. We started November 1 and our first decision, after a thorough investigation of the soil conditions, was to add a lot of sand and gravel, and also to under-drain them with tile. In order to lessen the cost, we dug the gravel out of the stream near the greens and covered the present soil to a depth of four inches. To this we added ten tons of manure; this was thoroughly worked so that it was a complete mixture of soil, gravel, and manure, and at this point may I strongly emphasize one thing — that experience has taught us that, whenever manure, sand, or any such substance is added to the soil, the mixture must be made as thorough as possible in order to obtain really good results. We then put in drains of three-inch tile, eighteen inches deep and twelve feet apart, with as big a fall as possible. On two greens it was possible to keep both ends of the drains open and these were protected by a fine wire netting. After this we tested our soil by flooding the green so as to see if it would take care of the excess of moisture. It is very difficult to say just how much sand or gravel should be added to a soil to make it right. The gravel should only be used for the lower stratum of your green, and

sand for the upper three inches, as gravel will spoil the putting as well as the mowers. Naturally, the depth depends on the size of the gravel. The ideal is a soil that will absorb enough moisture to take care of the grass roots in dry weather, that will raise the moisture in time of drought from the lower levels, and that will dispose of the excess. The latter can be tested out by flooding. Care must be taken, however, not to add so much sand that the soil will not retain enough moisture. Probably the simplest test is to squeeze the soil, when damp, in your hand and if it falls apart it is too sandy, but just previous to this stage it is about right. This I appreciate is a crude way of explaining soil structure, but is used because of the absence of a better one. The tremendous importance of soil structure cannot be over-emphasized. If it is bad, it does not make any difference how much you may fertilize or what you may do, you cannot have satisfactory greens. By satisfactory greens are meant greens that are in good shape most of the year and will stand a lot of wear. From our experience, soil structure is the foundation of green-keeping, and it is a simple matter, and relatively inexpensive, to make proper soil conditions when

constructing greens. It must be remembered that our experience has been with soils near Philadelphia. Surface drainage we found necessary, owing to the fact that wherever there was a hollow the grass died out. It was not due to winter kill only, but also to excess moisture at other times.

Seed.

Our putting-green mixture consisted of equal parts by weight of Creeping Bent, Rhode Island Bent, and Red Fescue (Chewings' Fescue), which made a very large percentage of bents on account of the smallness of the seed as compared to Fescue, about ten to one. When reseeding our greens, which we have done either once or twice a year, we have used nothing but Creeping Bent, as the Red Fescue did not grow well in our greens. Last year we used Rhode Island Bent¹ on account of the scarcity of Creeping Bent, due to the war. The fairway mixture on the first course consisted of equal parts by weight of Sheep's Fescue, Red Fescue (Chewings' Fescue), Slender Fescue, Creeping Bent, and Rhode Island Bent. Here again the bents

¹ Recent investigations have disclosed the fact that probably no genuine seed of Rhode Island Bent has been gathered in the last ten years. All of numerous samples examined prove to be either Creeping Bent or Redtop, mostly the latter.

predominated, but we obtained much better results in the fairways from the fescues, due, we believe, to the fact that the grass is not cut so closely. On our second course we omitted the Slender Fescue, which was of little value to us. The turf on the fairways is very similar to that on the putting-greens, and has given excellent results. It withstands drought, forms a fine mat, and makes little variation in the run of the ball from the fair-green to the putting-green. Our conclusion has been that it pays to buy good, clean seed from a reliable firm, and unless you are given the exact proportions not to buy mixtures. There is a lot of nonsense talked about secret mixtures. There are but few grasses that will form a first-class putting-green, and of the two main varieties, fescues and bents, one or the other will probably grow in your soil.

Grass.

The one important feature which has apparently been overlooked in the books on this subject, is the question of the length of grass. We have found that the fescues will grow splendidly in the rough or in the fairway, if they are not kept closely cut. We have also found that they would scarcely grow

at all in the greens where closely cut. Experience has taught us that the cutting of grass should be very carefully studied, and that if left at a good length, such as it is in the short rough way, say two or three inches, grass will grow and thrive under pretty nearly any conditions in our soil, whereas if it is cut down to our fairway length, that is, close cutting for fairways, it will not stand so much wear. When we get to the extreme of putting-greens, where the tendency to cut closer and make greens faster has steadily increased, we find it indeed difficult to keep the grass in good shape during the whole year. From a greenkeeping standpoint, it would save a great deal of money and a great deal of worry if the grass were left longer, and it were not necessary to keep greens as fast as billiard tables in order to have them rated first class. A careful study of mowing in the hot months of summer has led us to adopt the practice of clipping the putting-greens frequently but not as closely as is possible. We also allow the grass both on the greens and fairways to go into winter a bit long, thus providing a thicker mat during the season when there is no growth. These methods we believe have greatly assisted the turf.

Sodding.

The general impression seems to be that seeding is preferable to sodding, but we are led to believe that the sodding is more satisfactory, if you have a supply of really good sod, on account of the saving of time and the guarantee, if the work is well done, of certain results. In the fall of 1915 three of the fairways left in the old pasture turf became so weak that we decided to try sodding them instead of seeding. This was done to save time and keep the course in play. We had a great deal of fine sod in the rough which was of no value there, so we started at 160 yards and sodded to 230 yards, with a width of 45 yards, and were surprised, not to say gratified, to find that it cost us less than one hundred dollars a fairway to do this work. This included not only the sodding but the plowing and fining of the ground, and the manure and fertilizer which were added. In the case of tees, it takes so long for grass, if seeded, to become strongly enough established to stand any wear, that we are thorough believers in sodding. To obtain good results in sodding tees and greens, we have found that the sod must be trimmed by putting in a box shaped like a picture-frame, about one

inch deep, and then trimmed with a draw-knife to an even thickness. Prior to this, all the sod is cut in pieces about a foot square, by marking off the green with a plank one foot wide and cutting along both sides of the plank. This makes each sod exactly the same length and breadth, and saves much time in fitting. It is then lifted and trimmed to even thickness before laying. The tee or green is carefully prepared before laying the sod, and then the sodding is started from the near side of the green and as the sod is laid on, planks are laid on top of the sod and the men work while standing on the planks. This prevents them from walking over the green and making impressions with their feet before the sod is laid. After this, the sod is allowed to settle three or four days before rolling, a heavy coating of sand being spread over, which will work into the cracks and level it off, then the sod is lightly rolled. After a few days longer, a heavy roller is put on and then the work is allowed to settle for as long a time as possible before using. Our best success has been with sodding late in the fall so that it can settle during the winter, and we have thus obtained an excellent playing surface by early spring.

Greenkeepers.

We have found that a greenkeeper should be a man who can diagnose any trouble quickly, and who will nurse the grass with infinite care. He must watch the course every day and practically all day, as changes come so very rapidly in turf. One of the great failings of greenkeepers is due to the lack of thought on the part of the committees. They have never taught them thoroughly the question of cost. After careful study, one of our members has worked out a budget which shows the detailed cost of the work month by month for the whole year. Of course, this cannot be adhered to in every detail, but the main object is to put the plan before the greenkeeper so that he can see just what he has to do and how much money he has to do it with. He then begins to figure a job not by the size but by the cost. It is most important to try to make the greenkeeper think in dollars and cents. The usual answer to a question of, "Do you think you can do this," will be, "Oh! yes, it is not a very big job," but if you ask the same man what it would cost, it would be hard for him to give an estimate. The cost of mowing the fairways and greens, in addition to all the general cost, becomes

an interesting and most profitable study. It is a very simple matter for the greenkeeper to keep track of the cost of a new bunker or the sodding of a green, and each time he does it he learns a little more about the cost question and why it is such an important factor in all work. It also gives him a new interest in the work, and a basis for competition with his former work, and we believe you will find that your greenkeeper is keener for knowing that the last bunker cost \$20.80 to build and that the next one he is going to build will cost a little bit less because he has figured a way of doing it more cheaply. We have obtained splendid results by sending our greenkeeper to as many courses as possible in order that he may see what other persons are doing and profit by their good results, as well as by their errors.

Labor.

The organization of labor has played a big part in making savings for us. For instance, one man has entire charge of all the machines. If for any reason a machine, either a horse machine or a putting-green machine, will not cut, it is brought back at once to the stable and a new machine taken out. The man who has charge of it then puts it in repair.

He adjusts all the machines, and the men who do the cuttings are not allowed to alter a machine in any way. In this way one man is responsible and attains a thorough knowledge of the machines. Surprisingly good results have been accomplished by this method of handling. The labor we have used has been Italian, and during four years' experience on the two courses, we have had absolutely no trouble with them and found them faithful, willing, and exceptionally well fitted to this class of work.

Rolling.

The question of rolling seems to be fairly well understood at present and all seem to be following the same line, that is, to use light rollers rather than heavy. We find that the heavy one can only be used safely in the spring and the fall. In the first period to put the ground down after the frost has gone out, and in the second period when the danger of packing is small, as the frost will come into the ground in a month or so. We use a heavy motor mower on the course only a very few times in a year. For fair-green mowers, the three pony machines yoked together are the most satisfactory. This lawn mower will do a tremendous amount of work

in a very short time, and at present seems to be so well constructed that it is not always breaking down. They do not pack the ground, as the weight is small compared with the ordinary horse machine, and trivial as compared to a motor mower. For the greens we use the light wooden rollers and try to see that the greens are not rolled when they are wet, either by rain or the dew. On our soil a crust will form if care is not taken in this regard.

Weeds.

The only weed that has given us really much trouble is Crab-grass, and so far we have found nothing that will have any effect on it except the actual plucking out of the plant. This is done as soon as it appears in our greens, and a careful watch is made to find the very first plants. As many extra men as we can afford are employed to pluck it out at once, and strings are put across the green and the spaces marked off so that the men will not miss any in the operation. As soon as one green is finished they go to the next and may have to return to the first inside of a week, if the growth is heavy, and weed it all over again. This we believe is the most economical way of handling the problem. While the first cost is heavy if you do it thoroughly,

the result, if you do not, is the loss of a great deal of turf, and a great deal of trouble and expense is stored up for the future. The other weeds, such as plantain, dandelions, and the like, we have found can be most easily destroyed by using an acid such as sulfuric. The simplest method is to use a pickle jar half full of sulfuric acid and with an instrument like a sharpened ice pick, or any sharp steel instrument with a wooden handle, put a drop of acid in the center of the weed. That is, simply dip the instrument into the jar and then stick it deeply into the crown of the weed. In a few days the weed dries up and disappears, and the green is not disturbed and torn up as it is when the weeds are dug out. We believe a man can cover at least twice as much ground in this way as he can by taking out the weeds with a knife or any other implement. As far as our experience shows, no harm has come to the ground from the use of the acid.

Grubs and worms.

The one insect that has bothered us most is the grub, *Cotinis nitida*. This has affected the greens chiefly, although at times the fairways also. While the use of a heavy roller has helped somewhat, and solutions, such as kerosene emulsion, may

slightly check the insect, they do not really eradicate the grub. The use of a straight piece of iron about the size of a lead pencil which is forced down the hole, followed by squirting into each hole kerosene emulsion, or any other solution that is deadly to the grub, has so far proved to be the only sure cure. This seems like a lot of work, and it is, but we have not found any way which is easier or less expensive.

As to worming the greens, we have tried bichloride of mercury and several of the different powders which are advertised by seedsmen. The powders seem to be the best method of applying the cure on account of the labor cost being much less. One of the great difficulties is, that the time of worming comes at the time of reseeding the greens and it is always a grave problem whether to seed first and worm afterwards, or to worm first and seed afterwards. We must admit we have not definitely settled in our own minds which is the better plan.

Fertilizers.

Nitrate of soda has been our mainstay on the greens. Our plan has been frequent applications in small quantities. On a green of 10,000 square feet we may use only ten pounds at a time, but we may use it every two weeks for a while. It is

mixed with sand and carefully watered in at once. On our fairways, bone-meal, 300 pounds to an acre, once a year, has been the regular ration, and results have been good. Ground limestone, 1000 pounds to the acre, has also been added with good results. We believe that if we were forced to use for all purposes only one form of fertilizer, we would take compost. Nothing that we have done has given as good results as top-dressing with compost; apparently it can be used with good results at almost any time of the year. Piles of compost on different parts of a course are real safeguards against many of the dangers that may arise, and the truly remarkable results that a light top-dressing will accomplish are astounding. One of the main faults of greenkeeping is to put all the attention and fertilizer on the greens and none on the fairways. There have been many examples of good fairways going to pieces because they were allowed to go year after year with little care and practically no fertilizer. We have found it very necessary to see that our fairways receive a considerable amount of fertilizer each year.

In conclusion, our experience has taught us the real importance of good soil structure for putting-

greens, the splendid result from the use of plenty of top-dressing, and the great advantage of intelligent cutting.

EXPERIENCE IN GROWING TURF ON THE COURSE OF
THE COLUMBIA GOLF CLUB NEAR WASHINGTON, D.C.

Dr. Walter S. Harban

The course of the Columbia Golf Club is of particular interest on account of the excellent results secured by top-dressing methods on a turf originally very poor, and on soil of low fertility. When the course was originally laid out in 1909 the whole area was plowed in fall, harrowed, and seeded the following spring, but the resulting fairways were very unsatisfactory. On the putting-greens a year or two later there was used unfortunately a large amount of Perennial Rye-grass in the mixture, and on many of the greens this still persists, but is gradually being crowded out by finer grasses. Since 1913 the welfare of the course has been under the care of the writer. The success in improving the turf to a high degree of perfection without at all interrupting play is an example of what may be accomplished by such methods.

When the course was built in 1910 there was very

little known of greenkeeping and men of even limited experience were not obtainable to give direction. Consequently faulty construction, inadequate preparation, meaningless endeavor, marked its development for several years, or until it seemed a hopeless task to do anything but start afresh. Under such conditions by the methods here related most satisfactory results have been obtained. Commencing in the summer of 1913, necessary materials of all sorts, such as soils, compost, tools, machinery, and the like, were secured for early active fall work.

Putting-greens.

The putting-greens received attention the first of September, when active work was started. They were raked thoroughly, removing very much undesirable grass. Many of them were forked and loosened up, others disked with the velvet lawn seeder. From 100 to 200 pounds of raw bone was broadcast and raked into the ground. A compost made of two parts of screened mushroom soil, one part of loam, and one part of sand, one-half inch deep, was applied and raked, smoothed, and rolled. The seeds were then broadcast and raked in, followed by rolling.

Every spring and fall as early as possible, the

putting-greens are reseeded where necessary, and always given a light dressing of the mushroom compost. In winter from one to two yards of sharp sand is applied at frequent intervals, at the rate of four to six wheelbarrow loads at a time to a green.

While the putting-greens in 1913 were poor, they have been improved under this treatment so that most of them may be classed as very excellent. Some of the Perennial Rye-grass which was originally seeded in them still persists, but is less evident each succeeding season. All new reseeded of the putting-greens is with a mixture of Creeping Bent and Red (Chewings') Fescue.

Fairways.

The fairways for the most part were rough, pitted, and broken. They were harrowed with a straight-tooth harrow, as well as the two-horse scratcher. Nearly an inch of good loam was spread on all thin places, and raw bone and a light dressing of mushroom soil applied. This was hand-raked, rolled with the heavy roller, and seeded, after which it was again raked and rolled. The results from this simple treatment were quick and have been lasting.

All of the fairways are dressed in early winter with a light application of mushroom soil. It will

be seen that the principal fertilization has been with mushroom soil, which is nothing less than horse manure which has been used in mushroom beds and removed after it has ceased to be productive for that purpose. The only effect of its use in the mushroom beds is to destroy all seeds and so completely rot it that it may readily be screened with a quarter-inch screen. It not only contains humus of excellent quality, but in a form readily available for grass purposes.

Care of putting-greens.

For years it was impossible to get a greenkeeper to cut the greens close in summer. After much insistence and finally absolute demand, two summers ago the greens were not only cut every day, but very close. The improvement was so marked in quality, texture, and strength of grass after the hot weather was over, that the greenkeeper now resents a suggestion even to let them go over a day. Get the surface of your greens true by very heavy rolling in early spring; afterwards use a light wooden roller frequently.

Watering.

There is no treatment in the care of a green requiring more painstaking than that of water-

ing. Careless watering does harm. The greens are watered in the daytime when a man can see what he is doing. Cool or overcast days they are watered in the mornings; on bright hot days, any time after two or three o'clock in the afternoon.

During dry weather, six greens are watered each day, or all once in three days. At first the sprinkler is allowed to play about ten minutes and then moved to another point. By the time the entire green has been covered the first watering has opened up the pores of the ground and started capillary action, when it is ready to receive more water. Each green is gone over four or five times, leaving the sprinkler longer each time but never to flood the surface or to the point of water-logging. By this method a green can be watered more easily and more quickly with less water and less injury. The lesson from nature of the benefits following an all day or night gentle rain, or of the disastrous results of a heavy downpour, will appeal to green-keepers. The nearer one keeps to nature in all green work, the greater will be the success achieved.

The heavy gasoline machine for cutting our fairways is used almost exclusively. Notwithstanding the fact that the course is hilly and the

soil a clay loam, yet each year the turf has improved greatly and to-day is probably not inferior to that of any other course in the country. May it not be the neglect to feed the soil that has caused such general condemnation of heavy rolling?

Grubs.

A most interesting discovery was noted last season through the medium of heavy rolling. The approaches to all the greens have been cut either by hand or horse-cutters. From the point where the heavy rolling left off up to the greens, the grub worm commonly known as the June-beetle completely destroyed all the grass. Other points on the course where heavy rolling was impossible were affected in like manner. This strongly indicates a means of combating the ravages of the pest that has done so much injury to many golf courses and thus far has defied all safe means of control.

Ants.

Two or three drops of carbon bisulfide dropped in an ant burrow and immediately covered with a wet bag or blanket will completely destroy ants. A small oil can with a long spout is the best way to apply the liquid. A few drops are sufficient, as much will burn the grass but not injure it seriously.

THE GROWING OF FINE TURF ON THE SANDY LOAM
SOIL OF LONG ISLAND FOR GOLFING PURPOSES

Charles B. Macdonald, National Golf Links

Links proper in Scotland, on which the famous golf courses such as St. Andrews, North Berwick, Prestwick, and Machrihanish, are laid out, is sandy ground, usually undulating, on the seashore. The sand having ceased to drift, the links are usually covered with bent-grass, furze, heather, whins, and the like. The term links in Scotland is synonymous with dunes as used in England and on which the best English golf courses have been laid out, such as Sandwich, Westward Ho, and Hoylake.

Confining myself to the links and dunes of the extreme eastern portion of Long Island, it may be stated that the sandy loam areas are far more bare of humus than similarly situated areas in Scotland and England, so that the seed-bed must be built to establish a good golfing turf. The National Golf Links of America, at Shinnecock Hills, is built on land much like that of the seaside courses in Great Britain as above described, but under American climatic conditions which present problems on which little successful experience is available.

While the light sandy loam is ideal for playing the game (and no course can be really perfect without it), the matter of securing good turf is far more difficult than on heavier soils. Grasses once established on a sandy loam soil give a character of turf which cannot be equaled for golfing purposes on a heavier soil such as is usually found on inland courses. The methods used and the results obtained on the National Links should therefore be of value to others who have a similar problem.

The two most important factors are: First, to procure pure seed of the grasses best suited to the conditions. Second, to prepare the soil so as to obtain the best results.

Grasses.

The natural grass of Long Island is Rhode Island Bent. It is evident everywhere, where the land is not too densely covered with dwarf shrubs and various kinds of sedge grass. This is the only fine grass to be found in quantity on the sandy loam soils on the eastern portion of Long Island. The difficulty is to get pure seed. Only on a small scale is it harvested commercially for seeding purposes in this country, and it takes an expert to tell by looking at the seed whether it is Rhode Island

Bent or Creeping Bent or Redtop. The difference in price is 25 cents a pound for the Bent against 10 cents a pound for Redtop, roughly speaking, hence the temptation to substitute a certain quantity of other seed which is sold as Rhode Island Bent.

Rhode Island Bent has a tendency to creep, and is similar to Creeping Bent, but it is not so vigorous a creeper as Creeping Bent from South Germany. Creeping Bent is excellent to mix with Rhode Island Bent for putting-greens. The blades of both grasses are fine and soft. Creeping Bent, however, does not resist drought quite as well as Rhode Island Bent.

New Zealand Chewings' Fescue is undoubtedly Red Fescue acclimatized and established in New Zealand, whence all the commercial seed is secured. It has been a source of great satisfaction to us to discover how well adapted this grass is to Long Island conditions. The grass is creeping in character and makes a hardy, excellent turf, and once matted it is difficult for weeds to find a foothold.

A mixture of Rhode Island Bent and New Zealand Chewings' Fescue makes a perfect "fair green."

Chewings' Fescue also makes an excellent putting-green, the only objection to it being that it does not keep as green as the bent grasses. It greens up later in the spring and in the summer months during the heat it becomes brown sooner than the bents, but it is far more hardy than the bents and will stand any kind of drought and such punishment as is inflicted on teeing grounds.

There is one peculiarity of Chewings' Fescue, and that is the loss of germinating power with age. The seed is harvested in New Zealand in February, and one should not fail to use it by the fall of the same year it is harvested, for it will lose 40 to 50 per cent of its germinating power if kept for another season.

One should also bear in mind that there is a far greater number of seeds in a pound of bent than in a pound of fescue, and in seeding this should be considered.

To my mind, there are no other seeds worth mentioning for the sandy loam soils of Long Island. All the fescues do well, but the other fescues are bunch grasses, and undesirable for golf courses, except they be used for the "rough" at the side of the "fair green."

Fair green.

The following is the manner in which we treated the soil for the "fair green" on Shinnecock Hills :

We did not plow, but cut the brush off throughout the summer while we were making our compost for the seed-bed. Cutting the brush left the roots in the ground to bind it, and these rotted into excellent humus in a few years. It requires nearly 140 tons of compost to top-dress one acre one inch in thickness for the fair green seed-bed. One inch is scant, two is better. Constant watching is necessary to avoid killing by drought, and the seeded fair green should be covered by light horse manure in winter to prevent winter-killing while the grass is young and tender. The 140 tons of compost is made up as follows :

- | | |
|----------------------------------|---------|
| 1. Finely ground limestone . . . | 10 tons |
| 2. Clay sandy loam | 20 tons |
| 3. Sandy peat muck | 75 tons |
| 4. Manure | 35 tons |

Compost Nos. 3 and 4 after thoroughly mixing, four months. Then mix Nos. 1 and 2 with it. Turn it over and let it stand through the winter.

Screen sufficient of the compost to mix the seed

in, distribute it on the ground evenly, rake lightly and then roll the ground firmly. Water when necessary.

A light dressing of nitrate of soda, 100 pounds to the acre, mixed with ground bone, 200 pounds to the acre, will help the grass after its germination. Put this dressing on immediately before a rain. Scatter the seed evenly, ten to twelve bushels to the acre.

Putting-greens.

The best putting-greens we have on Shinnecock Hills were built as follows: In order to conserve moisture, blocks of salt meadow sod, eight to twelve inches in depth, were first placed in the sand, disk-harrowed and cross-harrowed, until the surface was evened up; a heavy coating of crushed limestone was then placed on this frayed meadow sod; then a quantity of the best sandy loam obtained in the hollows between the hills was mixed with an equal quantity of our compost sufficient to make a six- to eight-inch bed for seeding. Some greens were seeded entirely with Rhode Island Bent, others with Creeping Bent, sometimes sold in England as "South German Agrostis," while others with New Zealand Fescue, but the larger number of the greens

were seeded with various mixtures of these seeds. Seed was used at the rate of three pints to nine square yards.

A good catch of grass does not imply that you have a good putting-green. It takes three years at least for these creeping grasses to mat. During the process of their matting they require eternal vigilance to destroy the weeds, injurious insects, and grubs. The whole green must be carefully nursed, with proper cutting, watering, and top-dressing when necessary. Always roll with light wooden rollers and not too much of that.

It is always best to water between sundown and sunrise. A thorough soaking every week or ten days is better than frequent superficial sprinklings.

The weeds hardest to eradicate are chickweed and pearlwort. My experience has been "get busy early and eradicate both by cutting them out." You will have no pearlwort if you do not roll too heavily and water too superficially.

I am in favor of putting both Yarrow and White Clover in the fair green mixture of seeds where the soil is particularly sandy, but never any clover in the putting-green. Yarrow grows strongly, creeps, binds the turf, stands the droughts better than any-

thing else I know of, and is always green. Yarrow must be closely cut.

White Clover also does well on Shinnecock Hills and helps the soil while the finer grasses are making a stand. In time the bents and fescues will, under heavy seeding, choke the clover out. In the meantime the clover is good for the soil as a fertilizer and binder.

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